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OF THE

CALIFORNIA ACADEMY OF SCIENCES

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FOURTH SERIES

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VOL. VI

1916

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SAN FRANCISCO  
PUBLISHED BY THE ACADEMY  
1916



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p. 6

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July 6, 1918



PROCEEDINGS  
OF THE  
CALIFORNIA ACADEMY OF SCIENCES  
FOURTH SERIES

VOL. VI, No. 1, pp. 1-17, pl. 1.

MAY 6, 1916

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I

EOCENE OF LOWER COWLITZ RIVER VALLEY,  
WASHINGTON

BY  
CHARLES E. WEAVER

*Assistant Professor of Geology, University of Washington, Seattle*

INTRODUCTION

The purpose of this paper is to place upon record the results of geologic and faunal studies made by the writer during the past three years in portions of the lower Cowlitz River Valley. The area under investigation is of special interest because of the large number of exposures of Eocene strata and the exceptionally well preserved faunas contained within them.

Surface outcrops of Tertiary formations in western Washington are largely obscured because of the heavy overburden of Pleistocene deposits. In King and Pierce counties much detailed work has been done so that the lithology and structure of the Eocene rocks is fairly well known.<sup>1</sup> The strata in this region are, however, almost entirely of estuarine origin, rendering it impossible to make satisfactory correlations with the Eocene of other parts of the Pacific Coast. Isolated outliers of Eocene rocks occur in many localities such as Crescent Bay

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<sup>1</sup>Willis, Bailey, and Smith, Geo. O., Tacoma Folio, U. S. Geol. Surv. 1899.

along the Strait of Juan de Fuca, the low hills about Tenino and Centralia in Chehalis County and the exposures on Coal Creek north of Columbia River in Cowlitz County. At these localities only fragmentary sections of the Eocene column of Washington can be studied. The region under discussion in this paper contains the most complete fossiliferous marine section occurring within the western portion of the state.

## REVIEW OF LITERATURE

One of the earliest important scientific references to the geologic conditions in this region is to be found in the report by Dr. Ralph Arnold<sup>2</sup> on "The Tertiary and Quaternary Pectens of California." He described *Pecten landesi* from this area. The following quotation is well worth noting: "*P. landesi* is found quite abundantly in a dark greenish sandstone bed that outcrops about 100 yards west of the junction of Stillwater and Olequah creeks (U. S. Nat. Mus. locality 4019) one-fourth mile southwest of Little Falls, Lewis County, Wash. It is also found in a similar matrix in the bed of Olequah Creek (U. S. Nat. Mus. locality 4024), one mile north of the first locality. It is associated in this formation with a characteristic Eocene fauna, among which are the following species: *Venericardia planicosta* Lamarck, *Thracia dilleri* Dall, *Crassatellites* sp., *Meretrix* sp., *Ostrea* sp., *Pteria* (cf.) *limula* Conrad, *Cardium* 2 sp., *Barbatia* sp., *Glycimeris* sp., *Corbula* sp., *Callista* sp., *Turritella* (cf.) *wasana* Conrad, *Fusus* 4 sp., *Ocenebra* sp., *Ranella* sp., *Calyptrophorus* sp., *Lunatia* sp., *Turbinella* (?) sp., *Murex* 2 sp., *Conus* sp., *Cassis* sp., *Tritonium* sp., *Dentalium* (cf.) *cooperi* Gabb, and *Nautilus* sp. This horizon is probably upper Eocene, possibly above the Tejon." Dr. Arnold's suggestion that this horizon is very high in the Eocene seems to be well in accord with more recent studies.

The Geology and Paleontology of this area is discussed in a paper by the writer<sup>3</sup> published in 1912. A large fauna was noted as occurring along the banks of Cowlitz River about one

<sup>2</sup>Arnold, Ralph, The Tertiary and Quaternary Pectens of California. Professional Paper 47, U. S. Geol. Surv., p. 52, 1906.

<sup>3</sup>Weaver, C. E., "A Preliminary Report on the Tertiary Palaeontology of Western Washington," Bull. 15, Wash. Geol. Surv., pp. 12-15, 1912.

and one-half miles east of the town of Vader in Lewis County. Many new species of mollusks were described and the fauna as a whole was referred to the Cowlitz formation which was regarded as of Eocene age and possibly older than the Tejon. A suggestion was, however, made that future studies might show that it was identical with the Tejon.

A further discussion of this region is to be found in a report by Arnold and Hannibal<sup>4</sup> on "The Marine Tertiary Stratigraphy of the North Pacific Coast of America." In this paper the Tejon is divided into three formations: the Chehalis, Olequah and Arago formations. They are referred to as the Tejon Series. The Chehalis and Olequah formations are present in the region involved in this report. The Arago is absent. On the basis of fossil floras colder climatic conditions obtained during the deposition of the Chehalis formation than during that of the Olequah.

During the last year an important paper appeared by Dr. Roy E. Dickerson<sup>5</sup> entitled the "Fauna of the Type Tejon: Its Relation to the Cowlitz Phase of the Tejon Group of Washington." Collections were made and studied from certain localities along the Cowlitz River and a number of new species were described. A total of 95 species are listed from Washington and 55 of these are found within the Tejon of California. The paper gives the results of studies at the type Tejon locality in southern California and makes correlations with the Cowlitz phase of the Tejon in Washington. He states "The Cowlitz phase of the Tejon of Washington appears to represent the same faunal facies as the fauna of the type Tejon, i. e., the *Rimella simplex* zone is present in both localities."

## GEOGRAPHY OF AREA UNDER INVESTIGATION

The region involved in this study is situated in southern Lewis County and extends from the town of Winlock southerly for a distance of fifteen miles to the town of Castle Rock. From east to west the area averages five miles in width. Just east

<sup>4</sup>Arnold, Ralph, and Hannibal, Harold, *The Marine Tertiary Stratigraphy of the North Pacific Coast of America*, Proc. Am. Phil. Soc., vol. 52, pp. 566-571, 1913.

<sup>5</sup>Dickerson, R. E., "Fauna of the Type Tejon: Its Relation to the Cowlitz Phase of the Tejon Group of Washington." Cal. Acad. Sci. Proc., 4th series, vol. 5, pp. 35-51, 1915.

of the town of Vader (formerly known as Little Falls and Sopenah) the Cowlitz River swings from its east-west course and assumes a due north-south direction. One mile south of Vader, Stillwater Creek enters Cowlitz River and about one-fourth mile south of the town, Olequah Creek joins Stillwater Creek. From this point Olequah Creek extends almost due north to Winlock. The Northern Pacific Railway between Portland and Seattle follows the valley of this creek.

The drainage of the entire area is southerly to the Columbia and the hills on either side rise gradually into a rolling timbered country. Eocene strata away from the banks of the creeks are not exposed but are covered with gravels and sands formerly deposited by Cowlitz River.

## STRATIGRAPHY

In the examination of this region a transit survey was made of Stillwater and Olequah creeks and the position of all fossil localities as well as observations taken upon strikes and dips definitely located. These data have been plotted upon the map accompanying this report.

Between the towns of Castle Rock and Olequah only four exposures of Eocene strata are known to occur. They consist of dark gray, sandy shales with intercalated basaltic flows. Two miles north of Castle Rock and 2,000 feet south of the Northern Pacific Railway bridge over Toutle River, there is an exposure in the railway cut composed of bedded tuffaceous materials together with sedimentary deposits of worked over basalt. These beds have a strike of N.  $75^{\circ}$  E. and a dip of  $5^{\circ}$  N. W. They are overlaid with Pleistocene deposits composed of sand and gravel intermixed with angular fragments of basalt, which appear to have been derived by rapid erosion from nearby bluffs of Eocene basalt.

From this point northerly for a distance of two miles the only exposures along the railway consist of Pleistocene gravels and sands. One and two-thirds miles north of the Toutle River bridge Eocene rock outcrops occur for a distance of 450 feet. The bluffs at this point are about 60 feet high and con-

sist of thinly bedded, fine-grained, dark brown shale containing a few narrow bands of sandstone. The total thickness of the sediments at this point is about 75 feet. They are overlaid with 35 feet of black basalt showing well defined columnar jointing. Both the sedimentaries and lavas have a strike of N. 80° E. and a dip of 10° to the N. W.

About one-half mile south of the railway bridge across Cowlitz River there is a third exposure of Eocene basalt but no sedimentary rocks. The lower portion of the bluff is made up of agglomeratic materials consisting of a heterogeneous mass of angular fragments of badly weathered, dense and vesicular basalt having a thickness of 20 feet. Above this is a flow of fine grained, dense, black basalt exhibiting a tendency to columnar structure. The approximate strike of these flows is nearly east and west with a low dip to the north. The eroded surface of this outcrop is overlaid with Pleistocene sands and gravels.

One-half mile north of the previously mentioned outcrop, and along the south bank of Cowlitz River at the railway bridge, basalts and sedimentary rocks again appear. At the south end of the bridge and along the river there is a quarry composed of basalt exhibiting pronounced columnar structure. Lying conformably below the basalts are dark shales and brown sandstones, which in places contain narrow carbonaceous bands. They are about 60 feet in thickness with a strike of N. 35° W. and a dip of 10° to the N. E. From this point northward to the town of Olequah no recognizable exposures of the Eocene occur.

At one of the above mentioned localities a single specimen of *Turritella uvasana* Conrad was collected, but aside from this, the only fossils occurring are a few plant fragments and wood. From observations taken upon strike and dip there appears to be a continuous low dipping series of sedimentary beds with intercalated basaltic flows extending from Castle Rock to Olequah. However, it is possible that there may be folding and faulting in the intervening covered areas. If the strata are continuously dipping northward they possess a thickness of at least 6000 feet. From Olequah northward to Winlock, where the strata are better exposed, a stratigraphic sec-

tion can be made. The sediments in the area between Castle Rock and Olequah are stratigraphically below those outcropping between Olequah and Winlock.

*Section between Olequah and Winlock:*—Strata of Eocene age outcrop in the banks of Olequah and Stillwater creeks and also along the railway track at many places between Olequah and Winlock. They consist predominately of massive, sandy, clay shales together with grayish brown sandstones containing carbonaceous seams. These materials are of marine, brackish and fresh water origin. With the exception of the basal portion of this section, basaltic flows are absent. The basal part involves certain sandstones and basalts outcropping at the town of Olequah. The upper portion of the section is two miles south of the town of Winlock. The actual contact of the upper limit of the Tejon and the overlying Oligocene has not been definitely determined. Four hundred feet south of the last Oligocene outcrop in the banks of Olequah Creek are Eocene shales containing a marine Tejon fauna. It is impossible to say whether the two formations are conformable or not. The strata have approximately the same strike, but the dip of the Oligocene is only  $2^{\circ}$  to the northeast, while that of the Tejon is  $27^{\circ}$  in the same direction. It is possible that the two formations are conformable but that in the interval of 400 feet between them the dip flattens out.

The lower portion of this section as exposed along Stillwater Creek to the southwest of Vader and as far south as Olequah is of marine origin. Stratigraphically above, these strata grade into those of brackish water origin and finally into those containing a freshwater fauna. Still higher up in the section they pass back to a brackish water condition and finally to marine. The entire upper portion of the section is a marine deposit. The total thickness of the Eocene section, as measured from Olequah to Winlock, is approximately 4970 feet.

The following stratigraphic section shows approximately the variations in the lithologic character of the sediments from the base to the top, including a part of the overlying Oligocene.

TOP OF SECTION	Feet
Banded sandstone and shale as exposed at the town of Winlock and in the banks of Olequah Creek to the west and northwest of town. The fauna occurring at Locality No. 229 is characteristic of this zone.....	500
Massive clay shale grading in places into sandy shale as exposed along the banks of Olequah Creek south of Winlock and also in the bank of Cowlitz River in Section 5, Township 11 North, Range 2 West, at fossil Locality No. 239 (locally known as the Graeco Ranch). This is the base of the Oligocene in this region .....	600
Top of Eocene section. Chiefly sandy shale grading into massive clay shale of a dark brownish gray color. Exposures representing this phase are not very abundant but contain occasional specimens of <i>Venericardia planicosta</i> Lamarck and <i>Turritella utasana</i> Conrad .....	960
Shaly sandstone .....	100
Slightly banded sandy shale.....	130
Slightly carbonaceous sandy shale.....	50
Sandy shale .....	430
Laminated sandstone and sandy shale.....	150
Shale, slightly sandy. The upper part of this zone contains an abundant marine Tejon fauna.....	340
Massive clay shale containing the fauna at Localities Nos. 1, 1a, 232 and 233, in the north bank of Cowlitz River, Section 25, Township 11 North, Range 2 West.....	50
Sandy clay shale. This is the base of the upper marine division of the section .....	70
Brackish water zone. Yellowish brown sandstone with interbedded lignitic layers. These sandstones often grade into carbonaceous sandy shales.....	520
Freshwater zone. Light gray massive clay shale, containing numerous freshwater Eocene invertebrates. Fossil Localities Nos. 295 and 303 occur in these shales.....	130
Lower brackish water zone. Sandy shales and shaly sandstones often grading into brownish yellow coarse grained sandstones. All are more or less carbonaceous. Fossil Localities Nos. 231, 234 and 300 occur within this zone.....	550
Lower marine zone. Sandy clay shales grading into shaly sandstones. Fossil Localities Nos. 240, 240b, 299, 241, 238, 301, 236, 298, 294 and 294a occur within this zone. The basal portion of this belt contains a few very narrow layers of brackish water sediments. Below this belt no detailed measurements of the strata have been made. The underlying strata are those involved in the area between Castle Rock and Olequah. Just below the base of these marine beds, flows of basalt and deposits of basaltic tuff are intercalated with the sediments, which appear to be predominately of brackish water origin..	390
Total thickness of measured strata between Olequah and Winlock .....	4,970
Possible thickness of unmeasured strata involved in area between Castle Rock and Olequah.....	6,000
Possible total thickness of Eocene as exposed in the lower Cowlitz Valley section .....	10,970

## STRUCTURE

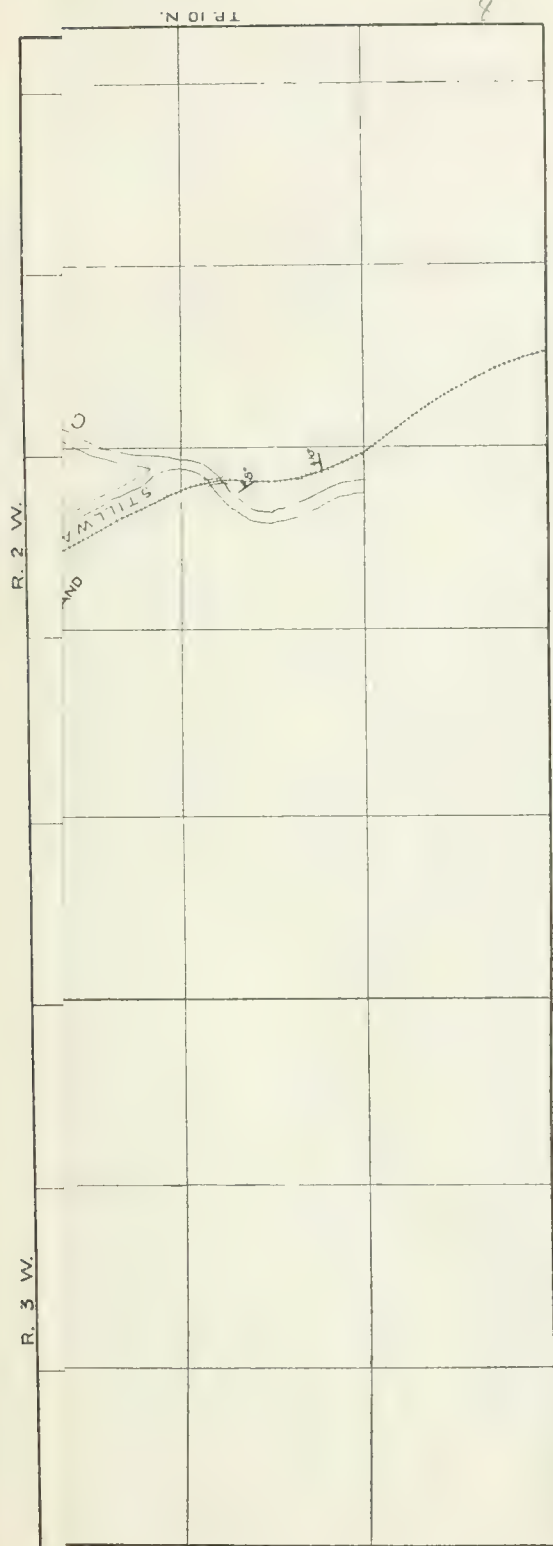
The entire series of Oligocene and Eocene deposits involved in this region exists in the form of a northeasterly low dipping monocline. It is probably the southwestern limb of a broad syncline, the northeastern limb of which occurs in the region around Chehalis and Centralia. There are minor undulations in the northeasterly pitch of the strata between Olequah and Winlock. In the vicinity of Vader a low, shallow anticline has been developed whose axis trends N.  $30^{\circ}$  W. It crosses Olequah Creek one-half mile north of Vader. The strata on the north side of this minor fold dip to the northeast at an angle of  $40^{\circ}$  and on the southwest side at an angle of  $15^{\circ}$ . One thousand feet south of the axis of the minor anticline there is a shallow syncline having approximately the same trend as the anticline. At the point where the axis of the anticline crosses Olequah Creek the same marine strata are brought to the surface which occur to the southwest of Vader along Stillwater Creek above its junction with Olequah Creek.

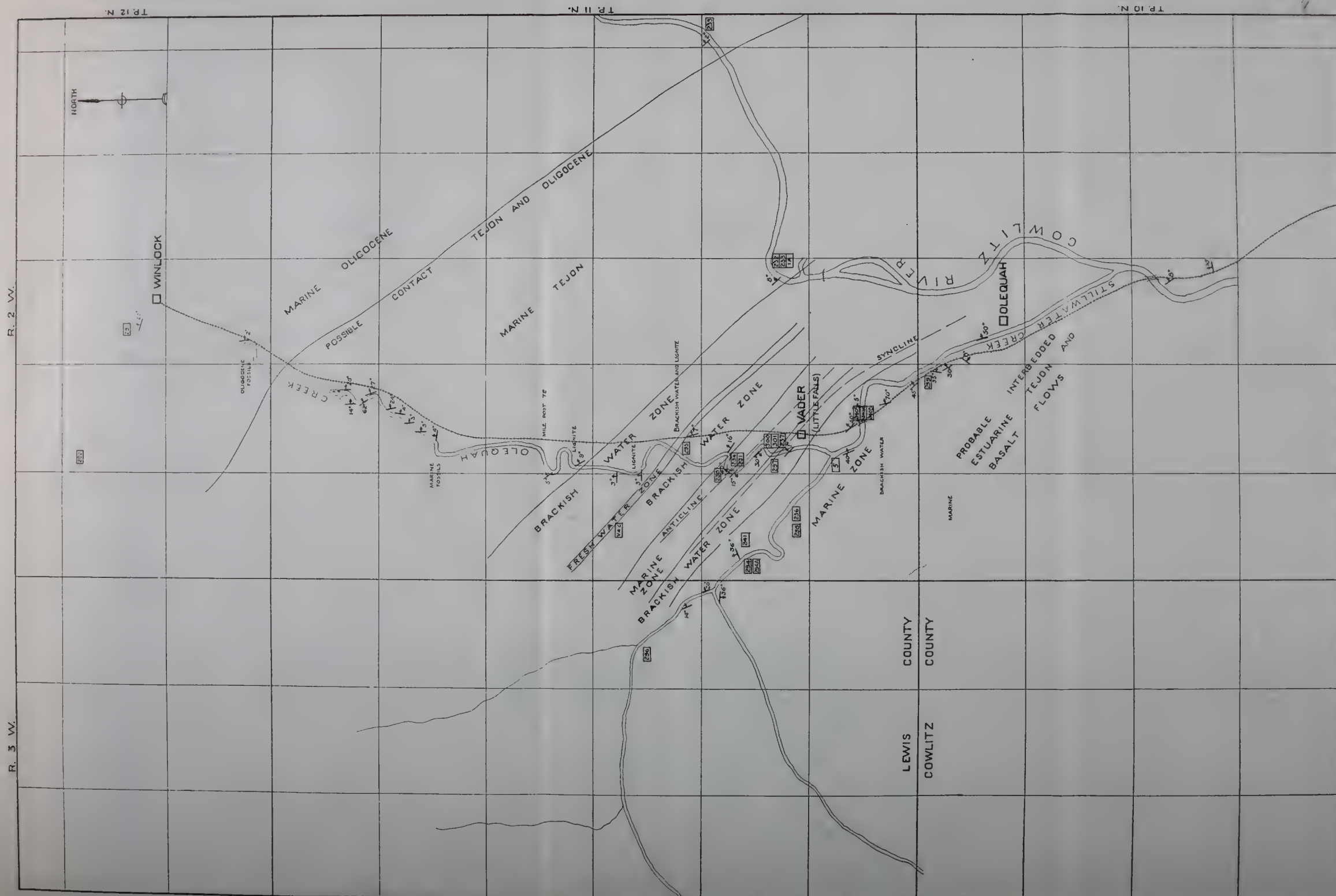
A glance at the map accompanying the report indicates several apparent discordances in strike and dip in the vicinity of Olequah. It might be inferred that the strata had been greatly disturbed and faulted. However, such is not the case. There are simply minor undulations in strike and dip along the prevailing direction of strike. The variations as shown upon the map were inserted for the purpose of emphasizing these irregularities.

## FAUNAL RELATIONS

In constructing the stratigraphic section accompanying this paper an attempt was made to arrange the fossil localities in their stratigraphic sequence. The following localities range from the base near Olequah to the upper portion of the section near Winlock: Localities Nos. 299, 5, 236, 298, 294, 294a, 241, 238, 301, 231, 234, 300, 295, 1, 1a, 232, 233, 239, 292 and 229.

Localities 299 to 301 contain a marine fauna. Localities 231 to 300 contain a brackish water fauna. Localities 295 and 303 contain a freshwater fauna. Localities Nos. 1 to 233





Sketch Map showing structural conditions along Cowlitz River between Olequah and Winlock.

contain a marine fauna. Localities Nos. 239 to 229 have a marine Oligocene fauna.

A description of the locations of the several fossil localities is here inserted.

- Locality No. 299—From an embankment along the Northern Pacific Railroad, 2850 feet south of milepost 76 and three-fourths of a mile north of Olequah Station, in Section 32, Township 11 North, Range 3 West.
- Locality No. 5—From a fossil ledge at the junction of Olequah and Stillwater creeks, in Section 32, Township 11 North, Range 3 West.
- Locality No. 236—On Stillwater Creek, Lewis County, 2200 feet above its junction with Olequah Creek, in Section 30, Township 11 North, Range 2 West.
- Locality No. 298—About 100 feet west of Locality No. 236.
- Locality No. 294—In the bank of Stillwater Creek about one and one-third miles below its junction with Olequah Creek in Section 30, Township 11 North, Range 2 West.
- Locality No. 294a—An earlier collection made at same Locality as No. 294.
- Locality No. 241—In the bank of Stillwater Creek about one and two-fifths miles below its junction with Olequah Creek, in Section 30, Township 11 North, Range 2 West.
- Locality No. 238—On Olequah Creek three-fourths of a mile north of Vader Station in the east bank of the creek just north of a point where a small creek enters Olequah Creek from the east. In Section 29, Township 11 North, Range 2 West.
- Locality No. 301—From the banks of Olequah Creek one-half mile north of Vader and south of the four-foot falls in the creek. The strata vary from a shaly sandstone to a sandy shale.
- Locality No. 231—Fossil Locality No. 234 should also be considered with No. 231, as they are both from the same locality, but from two separate ledges only eight feet apart. From Olequah Creek about three-fourths of a mile north of Vader, just south of the big bend in the creek. A small band of fossils. In Section 28, Township 11 North, Range 2 West.
- Locality No. 234—A narrow band in Olequah Creek about three-fourths of a mile north of Vader, just south of big bend in creek. About eight feet stratigraphically above Locality No. 231.
- Locality No. 300—On Olequah Creek one-fourth mile above Vader Station, in east bank of creek just north of point where small creek enters from east. In Section 29, Township 11 North, Range 2 West.
- Locality No. 295—Located about one and one-half miles north of Vader, in the bend in Olequah Creek at the point where the creek lies close to the Northern Pacific Railway track at milepost No. 73. The fauna is entirely of fresh-water origin and is in a belt of gray shale.
- Locality No. 1—Located about one and one-half miles east of Vader, on the west bank of Cowlitz River, in massive sandy shales of marine origin, situated in Section 27, Township 11 North, Range 2 West.

- Locality No. 1a—A zone at the base of the section as represented at Locality No. 1.
- Locality Nos. 232 and 233—A second collection made at Locality No. 1 and kept separate from No. 1.
- Locality No. 239—Located in the N.E.  $\frac{1}{4}$  of Section 25, Township 11 North, Range 2 West, on the east side of Cowlitz River three-fourths of a mile above the ferry on Mr. Greece's ranch. The fauna is Oligocene and is the equivalent of the faunas occurring south of Winlock in Olequah Creek at Localities Nos. 292 and 229.
- Locality No. 292—Oligocene, one mile south of Winlock in bank of Olequah Creek.
- Locality No. 240—An Eocene locality south of Vader in the banks of Stillwater Creek at a dam near the lumber mill. The locality is just east of the Northern Pacific Railway bridge over the creek. The strata are sandy shales and sandstones dipping at low angles to the north-east. Immediately above these strata brackish water species appear.

# FAUNAL LISTS

[illegible]



## FAUNAL LISTS—(Cont.)

Locality .....	299	5	236	298	294	294a	241	238	301	231	234	300	295	1	1a	232	233	240
<i>Conus remondii</i> Gabb .....														XXXXXX	XX	XXXXXX	XX	XX
<i>Conus weveri</i> Dickerson .....														XXXXXX	XX	XXXXXX	XX	XX
<i>Conus coultizensis</i> (Weaver) ..														XXXXXX	XX	XXXXXX	XX	XX
<i>Drillia ornata</i> Dickerson .....														XXXXXX	XX	XXXXXX	XX	XX
<i>Exilia dickersoni</i> Weaver .....														XXXXXX	XX	XXXXXX	XX	XX
<i>Exilia perkinsiana</i> (Cooper) .....														XXXXXX	XX	XXXXXX	XX	XX
<i>Ficus mamillatus</i> Gabb .....														XXXXXX	XX	XXXXXX	XX	XX
<i>Ficus</i> , new species .....		X												XXXXXX	XX	XXXXXX	XX	XX
<i>Fusus washingtoniana</i> Weaver ..														XXXXXX	XX	XXXXXX	XX	XX
<i>Fusus levisensis</i> Weaver .....														XXXXXX	XX	XXXXXX	XX	XX
<i>Fusus nitidus</i> Dickerson .....														XXXXXX	XX	XXXXXX	XX	XX
<i>Fusculina lucidula</i> Dickerson ..														XXXXXX	XX	XXXXXX	XX	XX
<i>Fusculina washingtoniana</i> Weaver ..														XXXXXX	XX	XXXXXX	XX	XX
<i>Fitopsis remondii</i> Gabb .....														XXXXXX	XX	XXXXXX	XX	XX
<i>Fitopsis coultizensis</i> Weaver .....														XXXXXX	XX	XXXXXX	XX	XX
<i>Galeodea washingtoniana</i> Weaver ..														XXXXXX	XX	XXXXXX	XX	XX
<i>Galeodea tuberculata</i> (Gabb) .....														XXXXXX	XX	XXXXXX	XX	XX
<i>Hemifusus sordidatus</i> Weaver .....														XXXXXX	XX	XXXXXX	XX	XX
<i>Hemifusus levisensis</i> Weaver .....														XXXXXX	XX	XXXXXX	XX	XX
<i>Hemifusus washingtoniana</i> Weaver ..														XXXXXX	XX	XXXXXX	XX	XX
<i>Hemifusus levisensis</i> Weaver .....														XXXXXX	XX	XXXXXX	XX	XX
<i>Lundinia coultizensis</i> Dickerson ..														XXXXXX	XX	XXXXXX	XX	XX
<i>Lundinia maculifrons</i> Gabb .....														XXXXXX	XX	XXXXXX	XX	XX
<i>Lundinia washingtonensis</i> Weaver ..														XXXXXX	XX	XXXXXX	XX	XX
<i>Murex washingtoniana</i> Weaver .....														XXXXXX	XX	XXXXXX	XX	XX
<i>Murex coultizensis</i> Weaver .....														XXXXXX	XX	XXXXXX	XX	XX
<i>Murex sordidatus</i> Weaver .....														XXXXXX	XX	XXXXXX	XX	XX
<i>Melania parkardi</i> Dickerson .....														XXXXXX	XX	XXXXXX	XX	XX
<i>Melania radfordi</i> Dickerson .....														XXXXXX	XX	XXXXXX	XX	XX
<i>Melania jetteli</i> Weaver .....														XXXXXX	XX	XXXXXX	XX	XX
<i>Melania levisensis</i> Weaver .....														XXXXXX	XX	XXXXXX	XX	XX
<i>Neritina watsoni</i> Dickerson .....														XXXXXX	XX	XXXXXX	XX	XX
<i>Neritina weveri</i> Dickerson .....														XXXXXX	XX	XXXXXX	XX	XX
<i>Neritina seta</i> Gabb .....														XXXXXX	XX	XXXXXX	XX	XX
<i>Neritina martini</i> Dickerson .....														XXXXXX	XX	XXXXXX	XX	XX
<i>Neritina coultizensis</i> Dickerson ..														XXXXXX	XX	XXXXXX	XX	XX
<i>Neritina triangularis</i> Gabb .....														XXXXXX	XX	XXXXXX	XX	XX
<i>Naticina obliqua</i> Gabb .....														XXXXXX	XX	XXXXXX	XX	XX



The above listed faunas are typically Tejon. The Cowlitz phase of the Tejon as represented at Locality No. 1 on the Cowlitz River one and one-half miles east of Vader was in a previous paper by the writer regarded as older than the Tejon, and more closely related to it than to the Martinez of California. Since the publication of that report more extensive collections have been made, as well as more detailed stratigraphic studies. The faunal evidence now points directly to its Tejon age. Dr. Dickerson<sup>6</sup> believes it is to be correlated with the type Tejon of Grapevine Canyon in southern California. He considers it to represent the middle division of the Tejon or *Rimella simplex* zone.

Arnold and Hannibal<sup>7</sup> in their report on "The Marine Tertiary Stratigraphy of the North Pacific Coast of America" consider two divisions of the Tejon to be present in the Olequah Creek region. The lower division or Chehalis formation is described as occurring at "the bluffs along Cowlitz River below the mouth of Drew Creek, one and one-half miles east of Olequah." It is apparent that they must have meant Vader rather than Olequah, as Cowlitz River is less than one-half mile east of Olequah, and the only rock exposures in that region are deposits of Pleistocene gravels and sands. Their faunal locality, No. 113, is probably the same as Locality No. 1, 1a, 232 and 233 of this report and California Academy of Sciences Localities Nos. 182 and 183, as referred to in Dr. Dickerson's report. Detailed stratigraphic measurements made with a transit show that the strata occurring at the above mentioned localities are stratigraphically higher than the strata exposed along Olequah Creek from a point two miles north of Vader southward to Olequah. The type locality of the Olequah formation as described by Arnold and Hannibal "extends from the Erwing ranch a little over two miles above Little Falls southward down Olequah Creek to Olequah, a distance of about five and one-half miles."

In this area, where both the Chehalis and Olequah formations are described as occurring by Arnold and Hannibal, stratigraphic evidence shows their lower division or Chehalis for-

<sup>6</sup>Dickerson, Dr. R. E., "Fauna of the Type Tejon: Its Relation to the Cowlitz Phase of the Tejon Group of Washington." *Cal. Acad. Sci. Proc.*, 4th series, vol. 5, pp. 39-51.

<sup>7</sup>*Op. Cit.*

mation to rest upon their upper or Olequah formation. Their evidence for two divisions here seems to have been based in part upon the evidence of fossil floras. An examination of the faunas obtained at various intervals from the base of section at Olequah to near the top at Winlock shows very little difference in their composition. It is true that near the middle of the section brackish and fresh water beds appear, but the marine faunas below and above are very similar. A comparison of the faunas occurring in the Eocene strata of the Cowlitz River area with those which have been listed and described from the type Tejon in southern California leads the writer to the same conclusions as have been stated by Dr. Dickerson, namely, that the Tejon of the Cowlitz River area is the equivalent of the middle zone in California as represented in the Mount Diablo region.

#### CONDITIONS OF DEPOSITION

The Eocene of western Washington is widely distributed. It extends well up into the western portions of the Cascade Mountains and may even possibly connect beneath a thick covering of Miocene lavas with the Eocene deposits on the eastern slopes of the mountains. The Eocene deposits involved within the western slopes of the Cascades are almost entirely of brackish or fresh water origin. No marine strata are known to be interbedded. In the Puget Sound Basin, brackish water deposits predominate, but in southwestern Washington great thicknesses of marine deposits are interbedded. During the upper Eocene the larger part of southwestern Washington and a portion of the Puget Sound Basin appear to have been an embayment of the ocean. The present site of the western slopes of the Cascade Mountains seems to have been in part occupied by large estuaries. During Tejon time diastrophic movements were differentially acting upon the entire western portion of the state, causing fluctuations in the depth of water in the embayments and estuaries and a shifting of the shorelines. These oscillations are recorded in the interbedded character of the marine and brackish water sediments. The eastern shoreline of the southwestern Washington embayment appears to have existed at times along the present site of the Northern

Pacific Railway line from Centralia to Portland. An interpretation of the stratigraphic section shows that this shore line was alternately shifting east and west as the sea floor was being differentially elevated and depressed. The effect of those diastrophic movements as recorded within the area involved in this paper may be seen in the passage from marine to brackish and fresh water and thence back again to marine. The marine faunas as listed above indicate tropical climatic conditions and an environment ranging from shallow water to moderately deep water.

### CONCLUSIONS

Within the area studied between Winlock and Olequah there are about 4000 feet of shales and shaly sandstones of upper Eocene age. Beneath these, between Olequah and Castle Rock, there are possibly 6000 feet of unmeasured upper Eocene sandstones and shales, together with numerous intercalated layers of basaltic lavas. Overlying the Eocene in the vicinity of Winlock and at the Graeco ranch on Cowlitz River are marine deposits of Oligocene age. A section of the Eocene measured between Olequah and Winlock consists of a lower division of marine beds at least 400 feet in thickness. This is overlaid by 550 feet of brackish water strata and that in turn with 300 feet of freshwater beds. Above the freshwater beds are 520 feet of brackish water strata. Above these are marine beds having a thickness of 2410 feet. These strata are all fossiliferous and appear to be most closely related to the middle Tejon as described in the Mount Diablo region of central California.

The basement upon which the Tejon in this area rests, as in the case of most of western Washington, is unknown. The fauna of the upper portion of the Cowlitz section bears a close relation to the overlying *Molopophorus lincolniensis* zone of the lower Oligocene as represented to the north in the vicinity of Lincoln Creek, in Thurston County.



PROCEEDINGS  
OF THE  
CALIFORNIA ACADEMY OF SCIENCES  
FOURTH SERIES

VOL. VI, No. 2, pp. 19-40.

MAY 6, 1916

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II  
THE POST-EOCENE FORMATIONS OF WESTERN  
WASHINGTON

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INTRODUCTION

Marine deposits of post-Tejon age form a considerable part of the formations exposed at the surface in western Washington. They have been folded and eroded, and, in some areas, are deeply buried beneath sand and gravel of glacial and fluvial origin. As a result, outcrops are usually found in the form of low cliffs along the banks of rivers and creeks or along the sea cliffs of the Sound or ocean. Certain portions of these Oligocene-Miocene formations yield fairly abundant marine invertebrate faunas. Upon a faunal basis five separate divisions of the post-Tejon portion of the Tertiary can be recognized. Marine deposits of Pliocene age with the exception of a very small area on the western side of the Olympic Peninsula are unknown within the state. The uppermost division or upper Miocene is separated from the lower four divisions by a well-marked unconformity. The pre-Pleistocene formations of the southwestern portion of the state are somewhat ob-

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scured by clays, sands and gravels of fluvial origin. In many areas the Tertiary rocks themselves have been so deeply weathered that very little information can be obtained concerning their lithologic character and structure. All parts of western Washington are clothed with a dense growth of forest and underbrush, which conceals many exposures of Tertiary rocks which are not covered with Pleistocene sands and gravels.

## LITERATURE

Numerous references to the occurrence of Tertiary strata may be found in papers dealing with the geology of western Washington. The majority of these papers involve investigations of economic products such as coal and contribute little to the purely scientific phases of Tertiary geology. Only the more important literature is here reviewed.

James D. Dana referred to Tertiary strata in the report on the geology of the United States Exploring Expedition under Wilkes<sup>1</sup> as occurring to the north of Columbia River and along the shores of Puget Sound and the Strait of Juan de Fuca. Collections were made from the south side of Columbia River at the town of Astoria. This fauna was identified by Conrad, who regarded it as Miocene.

Marine Neocene deposits are mentioned by Dr. Bailey Willis as occurring near Seattle immediately north of the northern limits of the Tacoma quadrangle.<sup>2</sup> These deposits are not described.

The first detailed description of the occurrence of Oligocene-Miocene strata within the state is to be found in a report by Dr. Ralph Arnold<sup>3</sup> on a "Geological Reconnaissance of the Coast of the Olympic Peninsula, Washington." Oligocene-Miocene deposits are described as occurring along the northern border of the Olympic Peninsula. Pliocene deposits are mentioned as being present on the west coast of the peninsula near the mouth of Queniult River. The Miocene deposits are composed of conglomerates, sandstones and shales which at-

<sup>1</sup>Dana, J. D., in U. S. Exploring Expedition, under command of Charles Wilkes, U. S. N., Philadelphia, vol. 10, 1838-1842.

<sup>2</sup>Willis, Bailey, Tacoma Folio, No. 54, U. S. Geological Survey, 1896.

<sup>3</sup>Arnold, Ralph, Bulletin Geological Society of America, vol. 17, pp. 451-468, September, 1906.

tain a thickness of 15,000 feet and have been folded into anticlines and synclines. Upon the basis of faunal evidence he states that the fossils of the formation indicate that the basal portion of the series is Oligocene in age, while the upper part is certainly Miocene. Since the separation of the two members will necessarily have to be made on paleontological grounds and will require a more detailed study of the material in hand than time has yet permitted, the term "Oligocene-Miocene series" will be used temporarily to designate the age of the beds. Arnold applied the term to this formation and recognized five faunal zones within it.

Further mention is made concerning the occurrence of Oligocene and Miocene fossils at Restoration and Beans points, just west of Seattle, by Dr. Ralph Arnold<sup>4</sup> and Dr. W. H. Dall.<sup>5</sup>

A paper published in 1908 by A. B. Reagan<sup>6</sup> and entitled "Some Notes on the Olympic Peninsula," describes the Tertiary rocks occurring in certain localities along the north and west sides of the Olympic Peninsula. Several new species of mollusks are described and figured.

In 1911, the writer, in a preliminary paper on the Tertiary of western Washington, described in a general way the distribution of the Miocene formations within the state. The following subdivisions were made: Lincoln formation of Oligocene age; Blakeley, Wahkiakum and Chehalis formations of Lower Miocene age, and the Montesano of Upper Miocene. Since the appearance of that paper, more detailed field work has been done by the writer. As a result, a large portion of the Chehalis formation is now included within the Wahkiakum and Montesano formations, and another division intermediate between the Lincoln and Blakeley is introduced, namely, the Porter.<sup>7</sup> The area along the western border of the Olympics represented upon the map accompanying the report as undifferentiated Lower Miocene, is of probable Jurassic age and is now referred to as the Hoh formation.

<sup>4</sup>Arnold, Ralph, Professional Paper No. 47, U. S. G. S., "The Tertiary and Quaternary Pectens of California," Washington, 1905.

<sup>5</sup>Dall, W. H., Professional Paper No. 59, U. S. G. S., "The Miocene of Astoria and Coos Bay, Oregon," Washington, 1906.

<sup>6</sup>Reagan, A. B., "Some Notes on the Olympic Peninsula," Kansas Acad. Sci. Geological Papers, pp. 131-238, 1908.

<sup>7</sup>Weaver, C. E., "A Preliminary Report on the Tertiary Palaeontology of Western Washington," Bulletin No. 13, Washington Geological Survey, 1911.

The most recent paper on the Tertiary of western Washington is by Arnold and Hannibal<sup>8</sup> on the Marine Stratigraphy of the North Pacific Coast of America, published in 1913. A four-fold division of the Oligocene is recognized. The oldest is represented by the Sooke formation of southwestern Vancouver Island. This is followed by the San Lorenzo, Seattle and Twin River formations. Above this is the Monterey, which is thought to be in part Oligocene and possibly in part lower Miocene. The upper Miocene strata, which are described as occurring on the south and west portions of the Olympic Peninsula, are believed to be the equivalent of the Empire formation of Coos Bay, Oregon.

### GEOGRAPHIC DISTRIBUTION

The Oligocene and Miocene deposits of western Washington exist in three separate areas. The largest and most representative area occupies the northern half of the Puget Sound basin and the north border of the Olympic Peninsula. A second area embraces the western portion of the Chehalis and Willapa river valleys in the southwestern part of the state. A third area constitutes a belt ranging from five to fifteen miles in width and trending east and west along the north shore of Columbia River. Within the Puget Sound basin and along the northern portion of the Olympic Peninsula, Miocene sediments are for the most part more or less heavily covered with deposits of glacial drift. They appear in the form of low sea cliffs along the shores of the entrance to the Bremerton Navy Yard, in the streets in the southern portions of the city of Seattle, and along the northern slopes of the Newcastle Hills. Along the north border of the Olympic Peninsula rock exposures appear almost continuously from Cape Flattery eastward to Port Crescent. Similar deposits occur within and along the shores of portions of the Quimper Peninsula south of Port Townsend. The Puget Sound Basin Oligocene and Miocene area is separated from that of southwestern Washington by basalts and sedimentary rocks of Eocene age. From the southern margin of the Olympic Moun-

<sup>8</sup>Arnold, Ralph, and Hannibal, Harold, "Marine Stratigraphy of the North Pacific Coast of America," *Proc. Amer. Philos. Soc.*, vol. 53, No. 212, November-December, 1913.

tain in Chehalis County, Oligocene and Miocene formations extend southerly to the middle of Pacific County. Outlying residuals occur in western Thurston and Lewis counties. Similar deposits of post-Tejon age are present in Wahkiakum County and in the southwestern part of Pacific County. They have been cut by the Columbia River and their southern extension forms a part of the well-known series of outcrops occurring at Astoria, Oregon. No marine deposits of Oligocene or Miocene age are known to occur within the Cascade Mountains or within the great basin area of eastern Washington. In these regions deposits of corresponding age are of igneous or freshwater origin.

### SEDIMENTATION

From the standpoint of stratigraphy the post-Tejon sediments occurring in the western part of the state are divided into two broad groups, separated by a well-marked unconformity. The older division includes deposits of Oligocene and lower Miocene age, while the younger involves sediments of upper Miocene and possibly lower Pliocene ages. During the Oligocene, embayments of the ocean were widely extended over western Washington with the exception of the central and western portions of the Olympic Peninsula. During the lower Miocene their extent became much smaller and by the opening of the upper Miocene they were almost entirely withdrawn. During the upper Miocene two small, shallow basins of deposition were formed. One of these existed in the basin of Grays Harbor and the other near the junction of Bogachiel and Solduc rivers in southwestern Clallam County.

During the Eocene epoch, southwestern Washington was occupied by an embayment of the ocean which seems to have extended as far north as the middle portion of the present Puget Sound basin. This fact is indicated by the occurrence of narrow bands of marine strata interbedded with those of purely brackish water origin. On the eastern shores of this embayment were situated extensive estuaries in which over 10,000 feet of brackish water sediments were deposited and which now form extensive outcrops in King, Pierce and Lewis counties. Igneous activity was characteristic of the larger

portion of the Tejon epoch but had almost entirely ceased by the opening of the Oligocene epoch. Near the close of the Eocene or at the opening of the Oligocene minor crustal movements brought about an encroachment of the marine waters into the Puget Sound basin and also into the present site of the Strait of Juan de Fuca.

In southwestern Washington the oldest deposits of post-Eocene age occur west of the city of Centralia in the valley of Chehalis River. They consist of indistinctly bedded, sandy, gray shales containing a marine invertebrate fauna which will be referred to in this report as the *Molopophorus lincolnsensis* zone. The strata containing the fauna may be referred to as the Lincoln horizon. At the present time the strata at this locality are approximately 1,000 feet in thickness. Away from stream, railway or wagon road cuts, rock exposures are largely obscured by a veneer of sands, clays and gravels, rendering it difficult to determine the exact areal limits of these beds. Fossiliferous strata outcropping in the banks of Olequah Creek near the town of Winlock and in the banks of Cowlitz River, six miles east of Vader, at the Graeco Ranch, may have been contemporaneously deposited with those at Lincoln Creek. The same may be true of the shales on Porter Creek north of the town of Porter in Chehalis County. They are unknown to the southwest in Pacific and Wahkiakum counties, as well as along the Strait of Juan de Fuca.

Toward the close of deposition of the Lincoln sediments the Oligocene seas expanded and occupied portions of the Strait of Juan de Fuca and the Puget Sound basin, as well as most of southwestern Washington. By the close of the Oligocene epoch these deposits had attained a maximum aggregate thickness of 15,000 feet. They consist predominately of shales and sandy shales within which local beds of conglomerate and sandstone are occasionally interbedded. The thickest and most complete section of the Oligocene is to be found in northern Clallam County along the northern border of the Olympic Peninsula. The section measured between Cape Flattery and Clallam Bay possesses a thickness of 13,300 feet. The basal beds are situated at the west end of Wyatch Slough and the upper about half way between Neah Bay and Clallam Bay.

## CAPE FLATTERY SECTION

Top		Feet
Massive sandstone .....		700
Chiefly shale, mostly concealed.....		900
Massive sandstone .....		175
Chiefly shale, mostly covered .....		800
Massive brown sandstone .....		300
Concealed .....		500
Massive, medium grained, brown sandstone.....		300
Alternating bands of grayish brown shale and sandstone.....	1,200	
Brown sandstone .....		200
Conglomerate .....		30
Brown sandstone .....		50
Conglomerate .....		50
Conglomerate with interbedded layers of shale.....		500
Coarse conglomerate .....		300
Grayish brown shale .....		700
Interbedded sandstone, shale and conglomerate.....		200
Massive, pebbly conglomerate .....		175
Hard, flinty shale .....		200
Sandstone with some interbedded shale .....		400
Interbedded massive sandstone and conglomerate.....		450
Massive conglomerate .....		30
Massive sandstone and intercalated conglomerate lense.....		300
Sandy conglomerate as exposed at Cape Flattery.....	1,400	
Interbedded sandstone and shale.....		150
Concealed, probably shale .....		500
Laminated sandy shale .....		200
Interbedded conglomerate and sandstone .....		250
Shale .....		350
Gritty sandstone with some interbedded shale.....		250
Brown shale .....		1,200
Brown banded sandstone .....		300
Total.....		13,300

Structurally the strata just described are involved in the badly wrinkled southwestern limb of a syncline whose axis trends from Port Crescent northwesterly diagonally across the Strait of Juan de Fuca. The strata forming the northeasterly limb occur fringing the south coast of Vancouver Island.

Deposits of Oligocene age are well developed in the low cliffs along the entrance to the Bremerton Navy Yard. These beds are a continuation of those occurring to the east at Alki Point and South Seattle, as well as along the north flanks of the Newcastle Hills. They have been sharply folded and deeply dissected by erosion, and later covered with deposits of glacial drift. The following generalized stratigraphic section has been constructed. The lowest beds exposed in the section outcrop at Orchard Point on the south side of Brem-

erton Inlet and the highest beds along the north shore of the entrance to Blakeley Harbor.

TOP OF SECTION	Feet
Massive, coarse grained conglomeratic sandstones containing numerous lenticular bands of conglomerates. Occasional, narrow bands of clay shale are interbedded.....	1,300
Sandy shales exposed beneath the waters of Blakeley Harbor.....	1,400
Brownish gray, massive to slightly bedded, sandy shales as exposed along the south shore of Blakeley Harbor for a distance of one-half mile northwesterly .....	2,400
Shaly sandstone grading in places into a shale. Stratification well defined. Upper portion of this belt is located at Restoration Point .....	1,200
Shaly sandstones gradually becoming more sandy in depth. Bedding, very distinct .....	450
Massive, sandy shales .....	350
Massive, brownish-gray, coarse grained conglomeratic sandstones and interbedded bands of coarse conglomerate, the pebbles of which attain a diameter of two feet. Many of the pebbles are composed of basalt and others of light colored shale and sandstone.....	1,800
Total .....	8,900

### SEQUENCE OF FAUNAS

In the report by Arnold and Hannibal on the "Stratigraphy of the North Pacific Coast," deposits of Oligocene age are referred to as the Astoria Series. This series is divided into three divisions, namely: the San Lorenzo, Seattle and Twin River formations. The distinctions between these formations are largely based upon differences of faunas rather than upon lithologic grounds. In the opinion of the writer, it would be preferable to refer to these divisions as faunal zones rather than formations. The application of the term San Lorenzo formation to the deposits described as such in Washington seems hardly justifiable. The type locality for the San Lorenzo is located in the Coast Ranges of California. Whether the strata assigned to the San Lorenzo in western Washington represent a part, all, or more than that, belonging to the formation in California, has not been determined. Until such information is available it would be misleading to make such direct correlation. If future investigations should prove that the deposits were formed contemporaneously, the term could with justice be introduced. Studies made by the writer on

faunas collected from the type localities of the Twin River and Seattle formations do not indicate sufficient grounds for making a separation. The Seattle formation is described as occurring on the south shore of the Strait of Juan de Fuca east of Twin River and east of Gettysburg. Detailed mapping in this region shows conclusively that the strata occurring there are involved in the east and west limbs of a syncline, and stratigraphical measurements prove the strata in question on each limb of this syncline to be identical. The arguments which have just been made concerning the use of the term San Lorenzo in Washington, at present at least, may be applied to the introduction of the term Monterey and Empire. The exact use of the term Monterey has not been definitely agreed upon in California. As more and more detailed information is obtained there is divergence of opinion as to what is to be included within the meaning of the term Monterey. The faunas of Washington and Oregon are not at present sufficiently known to permit any direct correlations. Suggestions can be made, but it would seem preferable to the writer to use local names provisionally and to gather all the information possible concerning formations or faunal zones in Washington and later, when such information is at hand, both in California and Washington, to make direct correlations. Misunderstandings as to what the writers are intending to convey will be less common. The gathering and recording of accurate information in the field is much more desirable than the attempt to make broad correlations with distant areas on insufficient and imperfect field data. After detailed studies have been made, such correlations can be made with confidence. In the meantime suggested similarities can be placed on record.

Five distinct faunal zones can be recognized in the post-Tejon strata of western Washington. The following table will illustrate their sequence:

- Montesano horizon—*Yoldia strigata* zone. . . . Upper Miocene  
—unconformity—
- Wahkiakum horizon—*Arca montereyana* zone. Lower Miocene  
—unconformity—

Blakeley horizon— <i>Acila gettysburgensis</i> zone . . . . .	Oligocene
Porter horizon— <i>Turritella porterensis</i> zone . . . . .	Oligocene
Lincoln horizon— <i>Molopophorus lincolnensis</i> zone . . . . .	Oligocene
Tejon group . . . . .	Eocene

### MOLOPOPHORUS LINCOLNENSIS ZONE

The oldest post-Tejon fauna which has been recognized within western Washington occurs in sandy shales outcropping along the south bank of Chehalis River five to 10 miles west of the city of Centralia, in Thurston County. Fossils in this locality are fairly abundant and in an excellent state of preservation. An examination of the faunal lists from this region indicates that several of the species are identical with those occurring in the underlying Tejon Eocene. Among these are *Brachysphingus clarki* Weaver, *Leda uvasana* Dickerson, *Crassatellites washingtoniana* Weaver, *Exilia dickersoni* Weaver, *Hemifusus washingtonianus* Weaver, and *Strep-sidura oregonensis* Dall.

The following species have been recognized as occurring in the rock bluffs along the south bank of Chehalis River west of Lincoln Creek. The strata containing the fauna may be referred to as the Lincoln horizon<sup>9</sup> and the fauna itself as the *Molopophorus lincolnensis* zone.

PELECYPODA	
<i>Cardium lincolnensis</i> Weaver	<i>Nucula washingtonensis</i> Weaver
<i>Cardium lorenzanum</i> (Arnold)	<i>Ostraca lincolnensis</i> Weaver
<i>Crassatellites washingtoniana</i> Weaver	<i>Solen curtus</i> Conrad
<i>Crassatellites coveyitensis</i> Weaver	<i>Solen parallelus</i> Gabb
	<i>Pitaria dalli</i> Weaver
SCAPHAPODA	
<i>Crenella porterensis</i> Weaver	<i>Dentalium stramineum</i> Gabb
<i>Leda uvasana</i> Dickerson	
<i>Leda lincolnensis</i> Weaver	
<i>Macrocallista pittsburgensis</i> Dall	
BRACHIOPODA	
	<i>Terebratalia</i> , sp.

<sup>9</sup>The use of the term Horizon is in the sense of a deposit formed at a particular time and identified by distinctive fossils.

GASTEROPODA	
<i>Ampullina</i> , new species	<i>Drillia hecoxi</i> (Arnold)
<i>Brachysphingus clarki</i> Weaver	<i>Lunatia cowelitzensis</i> Dickerson
<i>Bittium lincolnensis</i> Weaver	<i>Scaphander oregonensis</i> Dall
<i>Cancellaria</i> , new species	<i>Surcula lincolnensis</i> Weaver
<i>Calyptrea washingtonensis</i>	<i>Strepsidura oregonensis</i> Dall
Weaver	<i>Strepsidura lincolnensis</i>
<i>Drillia stanfordensis</i> (Arnold)	Weaver
<i>Exilia dickersoni</i> Weaver	<i>Molopophorus lincolnensis</i>
<i>Hemifusus washingtoniana</i>	Weaver
Weaver	<i>Turritella newcombi</i> Merriam

The above listed fauna seems to have a closer affinity with that occurring at Porter Bluffs, about 20 miles to the west in Chehalis County, and designated in this report as the *Turritella porterensis* zone, than to the underlying Eocene. The most important species which occur in common are *Cardium lorenzanum* Arnold, *Crenella porterensis* Weaver, *Dentalium conradi* Dall, *Drillia hecoxi* (Arnold), *Lunatia cowelitzensis* Dickerson, and *Malletia chehalisensis* Arnold.

*Marcia oregonensis* Conrad, *Thyasira bisecta* (Conrad), *Thracia trapezoides* Conrad, and *Phacoides acutilincatus* (Conrad) are entirely absent from the *Molopophorus lincolnensis* zone. They are, however, among the most common species to be found in the *Turritella porterensis* and *Acila gettysburgensis* zones.

The following species are most characteristic of the *Molopophorus lincolnensis* zone: *Cardium lorenzanum* Arnold, *Crassatellites washingtoniana* Weaver, *Leda uvasana* Dickerson, *Macrocallista pittsburgensis* Dall, *Pitaria dalli* Weaver, *Brachysphingus clarki* Weaver, *Exilia dickersoni* Weaver, *Lunatia cowelitzensis* Dickerson, *Drillia hecoxi* (Arnold) and *Strepsidura oregonensis* Dall.

A study of the faunas above listed indicates clearly a marked distinction between the Tejon fauna proper and the *Molopophorus lincolnensis* zone. A closer relation exists between the latter and the *Turritella porterensis* zone, although there are sufficient distinctions to warrant considering them separate faunal zones.

## TURRITELLA PORTERENSIS ZONE

The type locality at which this fauna may be found is located in the cliffs along the north bank of Chehalis River near the mouth of Porter Creek, in Chehalis County. Exposures of the same strata also occur in the banks of the small creeks entering Chehalis River from the north in the vicinity of Porter Creek. The most common species appearing in this zone are *Cardium lorenzanum* Arnold, *Crenella porterensis* Weaver, *Malletia chehalisensis* Arnold, *Marcia oregonensis* (Conrad), *Thracia trapezoidica* Conrad, *Thyasira bisecta* (Conrad), *Phacoides acutilineatus* (Conrad), *Drillia hecxi* (Arnold) and *Turritella porterensis* Weaver. Such species as *Acila gettysburgensis* Reagan, *Macrocallista vespertina* (Conrad), *Modiolus directus* Dall, *Panope generosa* (Gould), *Eudolium petrosus* (Conrad), *Turricula washingtoniana* Dall and *Turritella blakeleyensis* Weaver are absent. These species are, however, among the most characteristic occurring in the *Acila gettysburgensis* zone. It is possible that the *Turritella porterensis* zone may be represented beneath the lowermost beds of the *Acila gettysburgensis* zone south of Orchard Point at the Bremerton Inlet section. If so, it occurs between the lowest conglomerate belt of the *Acila gettysburgensis* zone and the underlying Eocene basalts near Port Orchard. This region is covered with glacial drift. The lower beds in the Clallam County area as exposed three miles west of Port Crescent may also represent this horizon.

## ACILA GETTYSBURGENSIS ZONE

The type locality where this fauna may be found is in the sea cliffs about the entrance to the Bremerton Navy Yard. The lowermost strata occur at Orchard Point. The highest strata outcrop along the north shore of the entrance to Blakeley Harbor. The total thickness of the beds here exposed is 8,900 feet. Detailed stratigraphic surveys show that the conglomerates at Orchard Point are below the sandstones and shales at Bean Point. The beds at Bean Point are about 2,000 feet below the fossiliferous beds at Restoration Point. The fauna

in the lower portion of this section is almost identical with that at the well-known locality just north of Restoration Point. In other words, there appears to be but one faunal zone represented within the strata exposed between Orchard Point at the base of the section and the north shore of Blakeley Harbor at the top of the section.

The most characteristic species of the *Acila gettysburgensis* zone are *Acila gettysburgensis* Reagan, *Macrocallista vespertina* (Conrad), *Marcia oregonensis* (Conrad), *Modiolus rectus* Dall, *Panope generosa* (Gould), *Phacoides acutilineatus* (Conrad), *Spisula albaria* (Conrad), *Solemya ventricosta* Conrad, *Tellina oregonensis* Conrad, *Thracia trapezoidea* Conrad, *Thyasira bisecta* (Conrad), *Crepidula praeclupta* Conrad, *Eudolium petrosum* (Conrad), *Miopleiona indurata* (Conrad), *Turricula washingtoniana* Dall and *Turritella blakeleyensis* Weaver. Such species as *Acila gettysburgensis* Reagan, *Solemya ventricosta* Conrad, *Eudolium petrosum* (Conrad) and *Turricula washingtoniana* Dall appear for the first time in this zone. They are always among the most common species met with and are entirely absent from the *Turritella porteriensis* and *Molopophorus lincolniensis* zones.

### ARCA MONTEREYANA ZONE

The recognition of a fauna characteristic of the *Arca montereyana* zone was first mentioned as occurring in Wahkiakum County on the Alockaman River about 12 miles north of the town of Cathlamet. The strata are composed of sandstones and shales involved in a shallow synclinal trough. Deposits of sandstones and sandy shales outcropping along the Strait of Juan de Fuca from Pysht westerly to Clallam Bay, also contain a fauna belonging to this faunal zone. Similar faunas representing both deep and shallow water phases occur in the shales and sandstones in the Grays Harbor region. The sediments in which they occur were in part formerly referred to by the writer as the Chehalis formation.<sup>10</sup>

A complete list of the species occurring within this zone may be referred to in the faunal table on page 35. Among

<sup>10</sup>Bulletin No. 13, Washington Geological Survey, 1911.

the more characteristic species occurring in this zone are *Arca montereyana* Osmont, *Chione securis* (Shumard), *Diplodonta parilis* Conrad, *Acila conradi* Meek, *Arca trilineata* Conrad, *Marcia oregonensis* (Conrad), *Pecten propatulus* Conrad, *Panope generosa* (Gould), *Phacoides acutilineatus* (Conrad), *Spisula albaria* (Conrad), *Crepidula praerupta* Conrad, *Fusinus stanfordensis* (Arnold), *Polynices saxea* Conrad, *Sinum scopulosum* (Conrad), *Dentalium conradi* Dall, *Aturia angustata* Conrad, *Pecten fucanus* Arnold, *Tellina arctata* Conrad, *Venericardia quadrata* Dall, *Venus olympidea* (Reagan), *Venus clallamensis* (Reagan), *Ficus clallamensis* Weaver, *Tellina nevadensis* Anderson, *Cancellaria dalliana* Anderson, *Cancellaria condoni* Anderson, and *Leda ochsneri* Anderson. This fauna presents a very strong similarity to that occurring in the Monterey formation in California.

#### YOLDIA STRIGATA ZONE

The upper Miocene strata of western Washington everywhere rest with unconformity upon the older rocks. The fauna occurring within these strata is very different from that of the faunal zones just described. One of the most common and readily recognizable species among this fauna is *Yoldia strigata* Dall. It might be desirable to refer to this fauna as the *Yoldia strigata* zone.

Among the more characteristic species belonging to this zone are *Arca trilineata* Conrad, *Cardium meekianum* Gabb, *Macoma astori* Dall, *Mulinia densata* Conrad, *Pecten coosensis* Shumard, *Solen sicarius* Gould, *Siliqua nuttallii* Conrad, *Yoldia strigata* Dall, *Argobuccinum cammani* Dall, *Chryso-domus imperialis* Dall, *Phalium aequisulcatum* Dall, *Sinum scopulosum* (Conrad) and *Scutella gabbii* Rémond. A complete list of the species occurring in this zone may be found in the faunal table.

Strata containing fauna of the *Yoldia strigata* zone outcrop in the Chehalis valley in the vicinity of Grays Harbor, at the mouth of the Queniult River and in the lower valley of the Quillayute River. The faunas of the Quillayute and Queniult valleys may represent a slightly higher position than

those of the Chehalis Basin. Detailed studies at each of those localities will be required to determine that point.

No marine deposits are known to occur within the state younger than those near the mouth of the Queniult Basin except late Pleistocene beach sands around the shores of Puget Sound.

## CORRELATION

Sufficient evidence is not as yet at hand to warrant a direct correlation of the faunas or faunal zones of western Washington with those of California. The great unconformity existing between the upper and lower Miocene is general throughout the Pacific coastal region. The faunas of both the upper and lower Miocene are distinctly different in California and Washington. The upper Miocene fauna of Washington appears to have its closest resemblance to the San Pablo of California, but more detailed evidence must be secured before such a definite correlation can be made. The *Arca montereyana* zone of Washington appears to be the equivalent of the same zone in California. It is possible, however, that more or less may be included within the faunal zone in the north than in the south. The *Molopophorus lincolnensis* and the *Turritella porterensis* zones of Washington may be the equivalent of the *Agasoma gravidum* zone of California. It is possible that the *Acila gettysburgensis* zone is in part higher than the *Agasoma gravidum* zone in the south.

## CONCLUSIONS

The post-Tejon formations of western Washington consist of shales and sandstones of marine origin. These deposits contain a well-developed fauna which at the present time is imperfectly known. The total maximum aggregate thickness of the sediments is approximately 20,000 feet.

Five well-marked faunal zones are present, the uppermost of which is separated from the lower four by a well-marked unconformity and difference in character of species. This line

of separation is the division line between the upper and lower Miocene. The uppermost of the remaining four faunal zones is separated from the other three by well-marked faunal differences. It is lower Miocene in age while the three lower zones are Oligocene. The faunas of the Oligocene in western Washington show a gradual gradation from one zone into another.

Insufficient evidence is as yet available to warrant making direct correlations with the post-Tejon zones of California, yet suggested similarities appear.

#### POST-TEJON FAUNAL TABLE FOR WESTERN WASHINGTON

The following table contains a list of the species occurring in the post-Tejon strata of western Washington. A large number of new and undescribed species are present, which are not included within this list.

# POST-TEJON FAUNAL TABLE FOR WESTERN WASHINGTON

[illegible]







POST-TEJON FAUNAL TABLE FOR WESTERN WASHINGTON---(Cont.)

[illegible]



PROCEEDINGS  
OF THE  
CALIFORNIA ACADEMY OF SCIENCES  
FOURTH SERIES

VOL. VI, No. 3, pp. 41-52.

MAY 6, 1916

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III  
THE OLIGOCENE OF KITSAP COUNTY.  
WASHINGTON

BY  
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INTRODUCTION

The purpose of this paper is to place upon record the results obtained from geologic and paleontologic studies made in Kitsap County, Washington, along the north and south shores of the entrance to the Bremerton Navy Yard. Because of the isolated occurrence of pre-glacial outcrops, it seems desirable to select small areas of importance and to investigate the geology of them in as much detail as possible. The area involved in this study is located six miles west of Seattle and is of special importance because of the occurrence there of the most complete and representative section of the Oligocene within the Puget Sound basin. With the exception of the exposures along the south side of the Strait of Juan de Fuca, it is the most complete within the state.

The surface rocks in the larger portion of the Puget Sound basin are composed of deposits of glacial drift. In a number of small and isolated areas the older pre-glacial bedrock formations project up through the drift. Such exposures are usually found in the form of low sea cliffs or in the canyons of certain streams. The region under investigation is one of such areas.

May 6, 1916

## PREVIOUS INVESTIGATIONS

At various times during the last 10 years reference has been made in the literature on west coast Geology to the presence of Oligocene and Miocene fossils at Restoration and Beans points on the north shores of Richs Passage. In 1904 Dr. Ralph Arnold, in his paper on the Tertiary and Quaternary Pectens of California, refers to certain "shales near Beans Point, King County<sup>1</sup>," which contain a fauna of probable Oligocene age. Note is made concerning the occurrence of *Pecten peckhami* Gabb at U. S. G. S. localities 4112a and 4113, between Beans and Restoration points, King County. *Pecten clallamensis* Arnold is noted at Beans Point and "is associated with *Terebratula*, sp., *Turritella*, sp., *Marginella* or *Erato*, sp., *Natica* or *Lunatia*, sp., *Glycimeris*, sp., and *Astyris*, sp."

In 1909, Dr. W. H. Dall<sup>2</sup>, in his paper on the Miocene of Astoria and Coos Bay, Oregon, mentions the occurrence of Oligocene strata at Port Blakeley and Restoration Point, opposite Seattle. The following species are listed from these localities: *Ampullina mississippiensis* Conrad, *Mioleionea indurata* Conrad, *Turricula washingtoniana* Dall and *Aturia angustata* Conrad.

In 1911, the writer<sup>3</sup> in a preliminary paper on the Tertiary Palaeontology of Western Washington described the occurrence of lower Miocene strata and fossils in the Restoration Point and Blakeley Harbor area and provisionally referred to them as the Blakeley formation. These strata were recognized as a part of an extensive lower Miocene series involved in the north flank of a well-defined anticline trending from east to west across the Puget Sound basin.

The most recent report involving a discussion of the Restoration Point area is to be found in a paper by Arnold and Hannibal<sup>4</sup> on the Marine Stratigraphy of the North Pacific Coast of America, published in 1913. A three-fold division of the Oligocene is recognized: The San Lorenzo or lower, the

<sup>1</sup>Arnold, Ralph, The Tertiary and Quaternary Pectens of California. Professional Paper 47, U. S. Geological Survey, 1906.

<sup>2</sup>Dall, Dr. W. H., The Miocene of Astoria and Coos Bay, Oregon. Professional Paper 59, U. S. Geological Survey, 1906.

<sup>3</sup>Weaver, C. E., A Preliminary Report on the Tertiary Palaeontology of Western Washington. Bull. 13, Wash. State Geol. Surv., 1912.

<sup>4</sup>Arnold, Ralph, and Hannibal, Harold, The Marine Tertiary Stratigraphy of the North Pacific Coast of America, Proc. Am. Phil. Soc., vol. 52, pp. 573-579, 1913.

Seattle or middle, and the Twin River or upper. The lower and middle divisions are stated to occur at Restoration Point. The San Lorenzo formation is described as the "sandstones overlying the lower Astoria basalts west of Port Orchard Sound and forming the lower half of the Bainbridge Island section of the Seattle monocline." The Seattle formation is said to consist "of the upper beds of the northward dipping Seattle monocline extending from Restoration Point on Bainbridge Island across Admiralty Inlet." The Twin River formation is not believed to occur in the Puget Sound basin.

In none of the investigations so far undertaken has an attempt been made to work out the details of the stratigraphy.

#### GENERAL STATEMENT CONCERNING THE MARINE TERTIARY IN WESTERN WASHINGTON\*

All of the pre-glacial areal outcrops in the western part of the state with the exception of the central and western portions of the Olympic Peninsula and the San Juan Islands are of Tertiary age. Both sedimentary and igneous rocks are present. They were formed during the Eocene, Oligocene and Miocene epochs. With the exception of possible marine sediments in the extreme western portion of Chehalis County, no rocks of definite Pliocene age are known to exist. The history of the Pliocene in western Washington must be sought in terms of diastrophism and erosion.

During the Eocene epoch there were formed deposits of marine, brackish and freshwater origin. Intercalated with these are lavas and tuff of andesitic character. These deposits attain a total maximum aggregate thickness of at least 10,000 feet. The marine invertebrate faunas occurring within these strata indicate that only the Tejon or upper Eocene is present in western Washington.

Five distinct marine faunal zones can be recognized in the post-Eocene formations of western Washington:

*Yoldia strigata* zone.....Upper Miocene  
*Arca montereyana* zone.....Lower Miocene

\*A detailed report on the "Tertiary Formations of Western Washington" by the writer will be issued as a bulletin of the publications of the Washington State Geological Survey. Accompanying this report are detailed areal and structural geological maps of the western portion of the state.

Acila gettysburgensis zone.....Upper Oligocene  
 Turritella porterensis zone.....Middle Oligocene  
 Molopophorus lincolnensis zone.....Lower Oligocene

The strata in which these zones are contained are referred to in this paper as horizons, the term being used in the sense of a deposit formed during a certain time and identified by certain distinctive fossils.

The type locality for the Molopophorus lincolnensis zone occurs along the south bank of Chehalis River near the mouth of Lincoln Creek. This fauna possesses many characteristics in common with the underlying Tejon Eocene, but more with the Turritella porterensis zone above. The strata characterized by this fauna may be referred to as the Lincoln horizon.\*

The Turritella porterensis zone is to be found well represented in the sandstone bluffs along the north bank of Chehalis River near the junction of Porter Creek. The sediments containing this fauna have been referred to as the Porter horizon. Among the more characteristic fossils occurring in this fauna are *Phacoides acutilineatus* (Conrad), *Thyasira bisecta* (Conrad), *Thracia trapezoidea* Conrad, *Cardium lorenzanum* (Arnold), *Turritella porterensis* Weaver, *Drillia stanfordensis* (Arnold) and *Malletia chehalisensis* Arnold. It is possible that the upper portion of this zone may be represented in the extreme lower portion of the section at Orchard Point.

The type section of the third or Acila gettysburgensis zone occurs within the strata exposed near the entrance to the Bremerton Navy Yard. Most of the faunas from the post-Tejon and pre-glacial strata in the Puget Sound basin belong to this zone. The sandstones and shales containing the fauna form the Blakeley horizon.

The fourth division, or Arca montereyana zone, is to be found in the sandstones outcropping along Alockaman River in Wahkiakum County, 12 miles north of Cathlamet. It also occurs in the sandstone and shale exposures along the south

\*There is considerable doubt in the writer's mind as to the wisdom of using the term, horizon. In geological literature it is often used in a very loose sense. Sufficient geological field evidence is not available to warrant the term formation as yet. Without the introduction of an entirely new word to express the idea of an assemblage of varying types of rocks all of which are characterized by the same distinctive fauna, it becomes necessary to choose one which has been used most nearly in such a sense.

shore of the Strait of Juan de Fuca between Pysht and Clallam Bay. The strata are referred to as the Wahkiakum horizon.

Resting unconformably upon the Oligocene and lower Miocene sediments are shallow water deposits of upper Miocene age containing a distinctive fauna which may be referred to as the *Yoldia strigata* zone, or Montesano horizon.

## STRATIGRAPHY

From the western spur of the Cascade Mountains in King County, a prominent spur extends nearly due west into the Puget Sound basin. This spur includes the Issaquah and Newcastle hills. From Lake Washington it trends westerly through Seattle as a pre-glacial and, in part, submarine topographic feature. It crosses the Sound a little to the south of Bainbridge Island and reappears in the Bald Hills of central Kitsap County. Structurally this ridge is of anticlinal origin. Sedimentary and volcanic rocks of Eocene and Oligocene age are involved within it. Extensive erosion has deeply cut into it so that the Oligocene strata have been completely removed from the axis. The core is largely composed of Eocene basalts together with brackish water and marine sediments. The coal measures at Issaquah and Newcastle, together with the sandstone and shales between Duwamish and Renton, belong to this phase. The basalts which outcrop on the shores of Sinclair Inlet, as well as those southwest of Bremerton in the Bald Hills, belong to the basaltic phase of the Tejon-Eocene. Resting unconformably upon the Eocene rocks and forming a part of the north flank of the anticline just mentioned, are sandstone and shales of Oligocene age. These strata are exposed in the north slopes of the Newcastle Hills, in the street cuts of Columbia City and Georgetown (both of which are within the city limits of Seattle), along the shores of Bailey Peninsula and at Alki Point. West from Seattle they outcrop at the water's edge at the south end of Bainbridge Island and along the south shores of Richs Passage. They appear for a distance of a mile along both shores of the narrow channel northwest of Bremerton near Tracyton. To the north of these Oligocene outcrops, the only formations within the county exposed at the

surface are deposits of glacial drift. Presumably they are involved in a broad synclinal basin beneath the glacial drift of northern Kitsap County. The evidence for such a suggestion is to be found to the northwest on the Quimper Peninsula between Quilcene and Port Townsend. In that region the same Oligocene strata resting unconformably upon the Eocene basalts exist in a broad synclinal fold whose axis trends southeasterly and passes beneath the glacial covering of northern Kitsap County. It can be seen from the foregoing statements that the Oligocene beds exposed at the entrance to the Bremerton Navy Yard are a representative part of the Oligocene formations of the Puget Sound basin and as such are worthy of detailed study.

In the investigation of this particular region transit surveys were made along the shore lines wherever pre-glacial formations were exposed. All observations taken on the strike and dip of the strata were tied in to these traverses. Stratigraphic sections were also made with the aid of the transit. The distribution of the Oligocene strata as exposed along the shore lines, as well as the structural data, may be seen by referring to Fig. 1.

The Oligocene strata of this region are entirely of sedimentary origin. The Eocene lavas upon which these sediments rest are exposed about two miles southwest of Bremerton on the west shore of Sinclair Inlet. The position on the surface of the contact between the Eocene andesites and the Oligocene sediments in this region is concealed beneath deposits of glacial drift. Many of the pebbles forming the basal conglomeratic phases of the Oligocene strata are composed in part of the older andesite.

The lowermost strata exposed in this area outcrop at Orchard Point. The highest occur along the north shore of the entrance to Blakeley Harbor. The total thickness of the deposits as exposed between the lower and uppermost beds is approximately 8900 feet. The following generalized stratigraphic column is constructed from observations taken along the section (B-B') :



Figure 1: Sketch Map showing structural conditions in the vicinity of Port Blakely.

TOP OF SECTION		Feet
Massive, coarse-grained conglomeratic sandstones containing numerous lenticular bands of conglomerate. Occasional narrow bands of clay shale are interbedded. The eastward continuation of the conglomerates appears in the outcrops at Blakeley Rocks. These strata persistently pitch to the north at very steep angles and extend as outcrops from the north shore of Blakeley Harbor northerly for 1500 feet....		1,300 (A)
Sandy shales exposed beneath the waters of Blakeley Harbor..		1,400 (B)
Brownish gray, massive to slightly bedded, sandy shales as exposed along the south shore of Blakeley Harbor for a distance of one-half mile northwesterly. Five hundred feet stratigraphically above the beds exposed at Restoration Point is an excellent fossil locality, No. 13.....		2,400 (C)
Shaly sandstone grading in places into a sandy shale. Bedding planes are commonly well defined. The top of this belt is located at Restoration Point.....		1,200 (D)
Shaly sandstone gradually becoming more sandy in depth. Bedding planes, very distinct.....		450 (E)
Massive, sandy shales. Bedding planes, fairly distinct. Fossil locality No. 305.....		350 (F)
Massive, brownish gray, coarse-grained conglomeratic sandstones with interbedded bands of coarse conglomerate, the pebbles of which attain a diameter of two feet. Many of the pebbles are composed of andesite and others of light colored shale and sandstone .....		1,800 (G)
Total thickness .....		8,900

The westerly continuation of the strata as exposed in the above section reappears in cross-section A A'. The upper beds as exposed at Point Glover appear to be the equivalent of those in belt (C). The extreme upper portion of belt (G) as exposed at Orchard Point is the westerly continuation of the narrow conglomeratic layers occurring just east of Beans Point on the south end of Bainbridge Island. The conglomerates outcropping at Quarry Point are the equivalent of those exposed at Middle Point. From Middle Point they cross Richs Passage and appear in the cliffs at Fort Ward on the south shore of Bainbridge Island. At this point they become less conglomeratic and more sandy. Near Restoration Point they are the equivalent of the upper portion of belt (D). The shales and sandstones exposed between Point Glover and Middle Point are to be correlated with the sandy shales in belt

(C). The conglomerates in belt (A) and the shales in belt (B) do not appear on the south side of Richs Passage. It is possible, however, that the conglomeratic sandstones and interbedded shales near Tracyton and Phinney Point are the equivalents of those in belts (A) and (B). The following stratigraphic section has been measured between the basal beds at Orchard Point and the higher beds exposed at Point Glover along section (A A') :

Top of Section at Point Glover		Feet
Massive, sandy shale with poorly defined bedding planes.....		150
Shaly sandstone .....		70
Brownish gray, sandy, clay shale.....		500
Massive, brown sandstone.....		100
Gray, sandy shale.....		45
Brown, massive, coarse-grained sandstone.....		60
Interbedded shale and sandstone, shale predominating.....		140
Massive sandstone .....		80
Thickly bedded shale .....		200
Alternating beds of thinly bedded shales and sandstones.....		520
Banded sandstone and shale, shale predominating.....		40
Banded shale and sandstone, shale predominating.....		20
Thinly bedded, gray shale .....		70
Massive, brownish gray sandstone .....		40
Thinly bedded shale .....		30
Massive, brown sandstone .....		300
Mainly shale with a few narrow bands of sandstone.....		200
Mainly sandstone with a few narrow bands of shale interbedded.		30
Mainly thin bedded, clay shale without distinct bedding.....		900
Massive, brown sandstone.....		65
Alternating layers of thinly bedded sandstones and shale with occasional bands of sandstones four to five feet in thickness .....		90
Massive, brown sandstone, slightly banded.....		75
Banded shale .....		10
Thinly bedded shaly sandstone.....		40
Alternating bands of thinly bedded shale and sandstone.....		75
Massive, brown sandstone .....		20
Massive, brown gritty sandstone.....		35
Gray shale possessing well-defined bedding .....		100
Massive, brown sandstone containing bands of shale.....		30
Mostly shale with a few bands of interbedded sandstone. Strata in part concealed .....		1,800
Thinly bedded shale somewhat massive in places and containing occasional bands of sandstones averaging one foot in thickness .....		320
Massive, brownish gray sandstone containing pebbly and conglomeratic bands .....		1,400
Massive conglomerates composed of pebbles ranging up to two feet in diameter and composed in part of altered andesite..		15
Massive, gritty sandstone .....		60
Conglomerate .....		15
Massive, gritty brown sandstone. These are the lowest strata exposed in the Bremerton Inlet area.....		70
Total thickness .....		8,715

## FAUNAL RELATIONS

The invertebrate fauna occurring in the sedimentary rocks just described is entirely of marine origin. Altogether 42 species are present. In the lower beds outcropping at Orchard Point and represented by belt (G), the only species found are *Cardium lorenzanum* (Arnold), *Nucula*, sp., and *Tellina oregonensis* Conrad. In the following table the fauna listed from locality No. 13, comes from the sandy shales north of Restoration Point in belt (C). Locality No. 304 is located at the west end of Quarry Point and the fauna occurring there belongs to belt (C). Locality No. 305 occurs at Beans Point in the lower portion of belt (F).

The most characteristic species occurring in this region are *Acila gettysburgensis* Reagan, *Macrocallista vespertina* (Conrad), *Marcia oregonensis* (Conrad), *Modiolus inflatus* Dall, *Panope generosa* (Gould), *Phacoides acutilineatus* (Conrad), *Solemya ventricostata* Conrad, *Thracia trapezoidica* Conrad, *Eudolium petrosum* Conrad and *Turricula washingtoniana* Dall. The most fossiliferous portion of the formation is in belt (C). The fauna occurring in belt (F) except in the number of species does not differ greatly from that in belt (C). The conglomerates and coarse-grained sandstones composing the lowermost beds of the section as exposed at Orchard Point is almost entirely barren of fossils. This lower belt may correspond to the upper part of the Porter horizon or *Turritella porterensis* zone as exposed in the Chehalis Valley.

The fauna appearing in belt (C) at Restoration Point is almost identical with that occurring to the east within the city of Seattle, and in the sandy shales on the north slopes of the Newcastle Hills. It may also be correlated with that at Fiddlers Bluff about two miles south of the town of Snohomish. The shales and sandy shales outcropping between Pysht and Gettysburg are also to be referred to this horizon or faunal zone. The following table gives the distribution of the marine fauna occurring in the Bremerton Inlet area:

## FAUNAL LIST

	13	304	305
<i>Acila gettysburgensis</i> Reagan.....	*	*	*
<i>Arca</i> , sp.....	*		
<i>Cardium lorenzanum</i> (Arnold).....	*	*	*
<i>Chione cathartensis</i> Weaver.....	*		
<i>Crenella porterensis</i> Weaver.....	*		*
<i>Leda chehalisensis</i> Weaver.....	*		
<i>Macrocallista vespertina</i> (Conrad).....	*	*	*
<i>Marcia oregonensis</i> (Conrad).....	*	*	
<i>Modiolus directus</i> Dall.....	*	*	
<i>Modiolus inflatus</i> Dall.....	*		
<i>Mytilus sammammishensis</i> Weaver.....	*		
<i>Nucula conradi</i> Meek.....	*		*
<i>Ostraea</i> , sp.....	*	*	
<i>Panope generosa</i> (Gould).....	*	*	*
<i>Pecten peckhami</i> Gabb.....	*		
<i>Pecten</i> , sp.....	*		
<i>Phacoides acutilineatus</i> (Conrad).....	*	*	
<i>Solen curtus</i> Conrad.....	*	*	
<i>Solemya ventricostula</i> Conrad.....	*	*	*
<i>Spisula albaria</i> (Conrad).....	*	*	
<i>Tellina obruta</i> Conrad.....	*	*	*
<i>Tellina oregonensis</i> Conrad.....	*	*	
<i>Thracia trapezoidea</i> Conrad.....	*	*	
<i>Thyasira bisecta</i> Conrad.....	*	*	
<i>Yoldia impressa</i> Conrad.....	*	*	
<i>Yoldia oregona</i> Shum.....	*		
GASTEROPODA			
<i>Ampullina oregonensis</i> Dall.....	*	*	
<i>Crepidula praeputa</i> Conrad.....	*	*	
<i>Epitonium</i> , sp.....	*		
<i>Eudolium petrosus</i> (Conrad).....	*	*	
<i>Fusinus</i> , sp.....	*	*	
<i>Miopleiona indurata</i> (Conrad).....	*	*	
<i>Natica oregonensis</i> Conrad.....	*	*	
<i>Scaphander oregonensis</i> Dall.....	*	*	*
<i>Turricula washingtoniana</i> Dall.....	*	*	
<i>Turritella blakeleyensis</i> Weaver.....	*	*	
<i>Turritella newcombi</i> Merriam.....	*	*	
<i>Turris fresnoensis</i> (Arnold).....	*		
SCAPHOPODA			
<i>Dentalium conradi</i> Dall.....	*	*	*
CEPHALOPODA			
<i>Aturia angustata</i> Conrad.....	*	*	*
BRACHIOPODA			
<i>Hemithyris astorianna</i> Dall.....	*	*	*

## CONDITIONS OF DEPOSITION

At the close of the Tejon epoch the Eocene deposits were differentially uplifted. Early in the Oligocene new embayments were formed. The seas of the northern part of the

Puget Sound region were disconnected from those to the south in the Grays Harbor area. The shore line of the present site of the Puget Sound embayment appears to have existed somewhere between Seattle and Tacoma and to have extended in an east to west direction from the present site of the Cascade Mountains to the present location of the Olympics. The present contact between the Eocene and Oligocene formations in the Bremerton Inlet, or Kitsap County, area is much farther north than the original southerly limits of the shore line. The strata have been tilted from their original horizontal position into a nearly vertical position and as a result those sediments which formerly extended to the south have been entirely removed by erosion. The lithologic character of the sediments and the faunas occurring within them indicate that they were deposited in shallow to moderately deep water. No products of direct volcanic origin were poured out in this region during the Oligocene epoch. This is in sharp contrast to the conditions of volcanic activity during the Tejon.

### CONCLUSIONS

The area involved in this investigation is of special importance because within it occurs one of the most complete sections of Oligocene strata to be found in the state. There are approximately 8900 feet of conglomerates, shales and sandstones which are entirely of marine origin and rest unconformably upon older Tejon basalts and sediments. The contact in this area between the Tejon and Oligocene is obscured by deposits of glacial drift. The Oligocene strata form the north flank of an extensive east to west trending anticline, the axis of which has been deeply dissected by erosion. A marine fauna of 44 invertebrates is now known. The horizon represented is upper Oligocene. The fauna is a unit from base to top of section and is termed the *Acila gettysburgensis* zone.

PROCEEDINGS  
OF THE  
CALIFORNIA ACADEMY OF SCIENCES  
FOURTH SERIES

Vol. VI, No. 4, pp. 53-85, pl. 2.

MAY 8, 1916

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IV  
THE PACIFIC COAST RACES OF THE BEWICK  
WREN<sup>1</sup>

BY  
HARRY S. SWARTH

INTRODUCTION

The material upon which these observations are based is mainly from the collection of the California Museum of Vertebrate Zoology. Besides the Museum collection proper there are on deposit in that institution the Grinnell, Morcom and Swarth collections. The total aggregation of skins of *Thryomanes bewicki* in that Museum numbers 425 specimens. There was also available material in the Los Angeles Museum of History, Science and Art, including the collections of Messrs. Daggett, Law, Lamb, Richardson, and Willett, in all 109 specimens. To Messrs. Joseph Mailliard and John W. Mailliard the writer is under obligations for the loan of 52 skins, including splendid series of *marinensis*, and series of *drymoecus* and *charienturus* from regions not otherwise represented. From Mr. A. B. Howell 11 skins were borrowed, illustrating special points. Altogether, a total of 597 examples of the Pacific coast forms of *Thryomanes bewicki* were examined in the preparation of this paper. To the institutions

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<sup>1</sup>Contribution from the University of California Museum of Vertebrate Zoology.

MAY 8, 1916

and individuals above mentioned the writer is under deep obligations for the use of this material.

Next to the data obtained directly from this splendid series of specimens, the writer is inclined to give high place to the informational value of the field work incidental to its collection, in much of which he took an active part. The ideal material upon which to base conclusions as regards relationships and distribution consists of specimens in freshly acquired autumnal plumage, taken at the exact localities where the birds were born. As we have not usually any means of knowing the exact birthplace of a bird, the results of our studies must often depend upon assumptions based largely upon one's knowledge of the species in general and its usual mode of life. Just here is where it would seem that experience and information acquired through extensive field work would be invaluable in aiding in an analysis of the facts presented by series of skins—facts often in apparent conflict. The man who works from the dried skin alone is handicapped more than he usually realizes. In working out the relationships and distribution of closely connected forms, a labor entailing the handling of large series, anomalous specimens are frequently encountered, calculated to lead one astray. Some knowledge of the country and climate, the physical surroundings of the species in general, will frequently give a clue to the explanation, while intimate acquaintance with the bird in life will enable one, to a certain extent, to imagine himself in the bird's place and figure out what, under given conditions, is most apt to occur. The life history and habits of the species in general, the faunal complexion of its usual habitat, the nature and extent of variation in the individual and in the race, are all factors of prime importance, and are all to be learned in the course of field work, some of them in no other way. It is not enough, because a specimen bears a superficial resemblance to a race geographically placed more or less remotely from where it was taken, to place the said specimen with such race. In the writer's opinion, this has been done but too frequently in late years, resulting in extraordinary extensions of ranges of certain subspecies without due justification. Familiarity with the birds in life should serve as a most excellent check to such hasty conclusions.

For many reasons the genus *Thryomanes* as occurring in California is an attractive one to the student of geographical distribution. The birds exist in numbers where conditions are favorable. As the species is not sharply delimited associationally, conditions are more generally favorable than in many other groups of birds, and *Thryomanes* is consequently abundant and widely distributed throughout the state. The variability of the group is notable, birds from different regions exhibiting to a marked degree the types of characteristics which we have learned to look for in animals of the various areas. Thus there are these several factors:—abundance, with consequent accumulation of extensive series of specimens; disregard of associational barriers effective in many other species, with resulting general distribution, this condition permitting careful scrutiny of conditions existing between many stations but slightly separated geographically, though of different faunal aspect; and variability, birds from different regions exhibiting peculiarities of color, etc.—all combining to make this genus a profitable subject for careful examination.

#### MANNER OF OCCURRENCE

Wrens of the genus *Thryomanes* occur in fair abundance practically throughout the state of California. The genus in this state belongs pre-eminently to the Upper Sonoran zone, but it also occurs commonly in places in Transition, as in the northern coast region, and sometimes in Lower Sonoran, as in parts of the San Diegan region and the San Joaquin Valley. It is not found, however, in the high Transition and Boreal of the Sierra Nevada and the southern Sierras, and it is notably absent from the arid Lower Sonoran of the Colorado and Mohave deserts. This last was unexpected, as the species occurs commonly in regions of similar zonal character elsewhere. The above statements all apply to the *breeding* range of the bird. In seasons other than the nesting time there are exceptions, as noted beyond.

In certain other variable groups, such as the Song Sparrows (*Melospiza melodia*), Horned Larks (*Otocoris alpestris*) and Bush-tits (*Psaltiriparus*), associational requirements

are of such a nature as to bar the species from large areas, but *Thryomanes* demands no such rigid conditions for its existence. The essential environmental requisite is underbrush, affording shelter, and this is a condition so universally met with in California that there are few regions that do not answer.

Just one of the California forms of this species has truly migratory habits, *Thryomanes b. cremophilus*. The others are practically resident wherever found. It is true that this fact is not generally recognized, and that there are records of several subspecies from points more or less remote from the breeding ground, but I am convinced that for the most part these records are not well founded. In the extensive series of skins here assembled, and in the field work incidental to the accumulation of the large proportion of them in which the writer took part, there has been no evidence evolved indicating regular migrations of these birds. As evidence to the contrary, the following facts may be adduced: *Thryomanes b. calophonus* is stated to remain in winter at the northern limit of its range (Oberholser, 1898, p. 441), which is also the northern extreme reached by the genus in North America. We do not find *marincensis* or *spilurus* wandering south in winter along the coast of southern California, any more than we do certain other forms of comparable distribution and faunal restriction, such as *Pipilo maculatus falcifer*, *Zonotrichia leucophrys nuttalli*, *Junco oreganus pinosus*, etc. In the extensive series of wrens assembled from southern California and from parts of the Mohave and Colorado deserts, numbering some hundreds of skins secured at all seasons of the year, there is none that can be considered as typical of *Thryomanes b. drymoeus*, to be taken as proof of a southward winter movement of this form.

*Thryomanes b. cremophilus* appears to be truly migratory. Data are lacking to show whether or not the breeding ground is entirely deserted in winter, but the subspecies is known to occupy parts of the Colorado desert during the winter months, while it does not nest in that region. The birds found on the Colorado Desert during winter are apparently migrants from the desert mountains to the northward, and not from eastern Arizona, where this wren is a common resident. Though the Desert Wren has been found in winter to the eastern base

of the mountains separating the desert and coastal regions, there is no known instance of an individual of this subspecies having crossed the divide and invaded the Pacific slope.

While I am convinced of the truth of the statements made above regarding the generally non-migratory habits of the California wrens of the genus *Thryomanes*, excepting *eremophilus*, there do take place certain limited and irregular movements which are not to be considered as migrations. The late summer dispersal of birds in general, the "scatter movement," as it has been called, is common to many parts of the country, and may take individuals, mostly immatures, in any direction. The northward wandering of herons at the close of the breeding season is a well-known instance in point. In parts of California this movement takes the form of an invasion of high mountain regions by many low zone species from the adjacent valleys and foothills (see Grinnell, 1908, p. 22), and *Thryomanes* participates in this to a notable extent. In southern California during July and August, *T. b. charienturus* is one of the most abundant birds in the higher mountains, at altitudes where it never breeds, occurring in numbers to the summits of the highest peaks. As early as the middle of September this invading army has again withdrawn. Several specimens at hand from parts of the Sierra Nevada seem also, from dates and altitudes, to have been wanderers from lower elevations.

This general movement is apt to carry occasional individuals of any of the forms *slightly* beyond the usual faunal confines of their respective races, and there are several instances in the assemblage of skins examined where circumstances seem to indicate a happening of this nature.

The occurrence of *T. b. charienturus* in winter at stations in the western parts of the Mohave and Colorado deserts (as at Barstow, Victorville and Palm Springs), is easily explained as due to continuous favorable avenues of approach from the normal breeding grounds in the foothills of the nearby mountains. Other species properly belonging to the San Diegan faunal region have been similarly found at the same places.

## VARIATION

There are but two distinguishable stages of plumage in this species (besides the natal down)—the juvenal and those of the first and subsequent winters. The juvenal differs from the later stages mainly in being mottled or spotted over much of the area that is subsequently uniformly colored. After loss of the juvenal plumage, in the first August and September, there are no further changes in appearance, immatures of the first winter being indistinguishable from adults; after the first year there is but the one molt annually, at the end of the summer. There are thus no seasonal changes in appearance other than those produced by the mechanical wear and tear upon the plumage, amounting to fading of colors proportionate to the nature and extent of exposure, and obliteration of finer markings as the feather tips are worn away. There are no appreciable sexual distinctions of color or markings, merely slight average differences in measurements, males averaging a trifle larger than females.

It is seen that the wrens of this genus have a wide zonal range, and that where a change in life-zones acts as a check, it is, in this group as in most others, usually an absolute barrier to the species rather than an accompaniment of subspecific variation. It is also evident that environmental requirements are not rigid, the species being readily adaptive within rather wide limits. While the species as a whole is wide ranging, however, there is a strong tendency toward separation into different forms or races distinguished by peculiarities of color and proportions. Study of this variation demonstrates close accordance of appearance with locality. In this group of birds each faunal area represented tends to a remarkable degree to produce its own peculiar type. So that it is seen that *Thryomanes*, wide ranging and with the faculty of thriving under varied climate and surroundings, exhibits to an extraordinary extent—perhaps as part of this same adaptability—variation of appearance in accordance with every change in environment.

It must be understood, of course, that the differences alluded to are not always conspicuous. There are frequently variations in proportions requiring careful measuring for detection, or slight differences in color which in scattered speci-

mens might be thought of no especial significance. With a series as extensive and representative as the one here assembled, however, these variations can be recognized as parts of a coördinated whole, and in the occasional instance where an insufficient specimen or two from some obscure locality exhibits an unexpected line of development, there is usually to be found at least a possible explanation of the occurrence.

The extent and manner of variation illustrated in this series of birds can not be too strongly emphasized. For one thing there are enough specimens at hand to show a surprising range in characteristics from any one locality. Many stations are represented each by numerous specimens of freshly molted fall birds, undoubtedly individuals of the resident form of each respective place, as they appear prior to any wear and tear of the plumage. In every case there are individuals exhibiting wide variation in appearance, though extremes may be shown by but one or two specimens. These differences can not be explained save as illustrating the amount of variation to be encountered among individuals at any one point.

These variants are not of the same nature as the "intermediates" encountered near the line of meeting of two different races. In the latter case, as is well illustrated from many such localities in the series here assembled, we find *whole populations* showing characters variously intermediate between two extremes. The occasional variants found elsewhere may crop up at any place, and in appearance do not necessarily incline towards any other subspecific type. It would almost seem as though the species as a whole was in a formative stage, showing occasional response to stimuli which we cannot at present understand.

In this connection it is well to consider conditions in the juvenal plumage. In the several distinguishable Pacific coast forms of *Thryomanes bewicki* the color differences shown in the adults are accurately reflected in the juvenal plumage, young birds of the different recognizable subspecies exhibiting variations of precisely the same nature as are seen in adults, usually in about the same degree. This, according to the general understanding of the significance of characters of the juvenal plumage, would argue great age and consequent deep-seatedness of the color characters observed, which is hard to recon-

cile with the generally variable nature of the several subspecies as observed at this time.

The above statements must not be understood as weighing against the validity of the several "subspecies" so far described from California, for in nearly every case where a name has been applied to a local race it covers an aggregation of characters fairly easily defined and recognized. In fact, the races of *Thryomanes bewicki*, as occurring on the mainland of the Pacific coast, may be taken as an ideal illustration of subspecific division as it is applied in systematic ornithology. There are six recognized forms in this region—*marinensis*, *spilurus*, *drymoeus*, *charienturus* and *cremophilus* in California, and *calophonus* in the coast region to the northward. In every case it is an easy matter to distinguish typical examples of the races. Typical specimens are not necessarily topotypes. The best manifestation of a race may be found at some distance from the type locality; usually at about the center of the geographical area occupied. As departure is made from the habitat of one race toward that of another, in just such proportion is variation encountered among individuals of the races. Geographical continuity of range with corresponding intergradation of characters is usually taken as the test of subspecific, rather than specific, difference, but there are few instances among North American birds where these conditions are as ideally met with as among the Pacific coast forms of *Thryomanes bewicki*.

A brief resumé of the course of variation in some of the most salient features of these races may be profitable. At the extreme northern limit of the species, on the mainland of southern British Columbia and Washington, is *calophonus*, of relatively large size and extremely dark coloration. On the adjacent Vancouver Island is a slightly paler colored, rather more reddish, form (included under the name *calophonus*), of practically the same size. Farther south, on the coast of northern California, southward to the Golden Gate, is *marinensis*, about like Vancouver Island *calophonus* in color but appreciably smaller. South of the Golden Gate is *spilurus*, occupying the narrow coastal strip west of the Coast Ranges, south to about the southern end of Monterey Bay. This form is of a somewhat paler and brighter red than is *marinensis*,

and of slightly greater size. South of *spilurus* is *charienturus* of the coast of southern California, a large sized, pale colored, and long tailed race. There are two inland races of *Thryomanes* in California, *drymoecus* and *cremophilus*. Typical *drymoecus* of the Sacramento Valley is of distinctly reddish coloration, most nearly like, though paler than, *marinensis* and *spilurus*, whose ranges it adjoins in places. *Eremophilus* is a desert race, exhibiting an extreme of pale coloration, and with relatively long tail. Of the insular forms, *nesophilus* of Santa Cruz and Santa Rosa islands, and *catalinae* of Santa Catalina Island, are but slightly different from the geographically adjacent *charienturus*. They are a trifle darker in coloration, and show certain differences in proportions. *Leucophrys*, of San Clemente Island, is a short tailed race of distinctly pale coloration.

As regards the coastal races, from *calophonus* through *marinensis* and *spilurus* to *charienturus*, the line of variation is continuous, to be traced from one to another without a break. In coloration, from the sooty *calophonus* to the pale *charienturus*, intergradation is perfect. The intermediate stages are represented in *marinensis* and *spilurus*, the dividing lines between these several races being impossible of exact definition. This gradual color change is nicely correlated with the climatic variation of the region, from the extremely humid Puget Sound district, with its somber hued *calophonus*, southward through lessening degrees of humidity accompanied by corresponding brightening of color in the birds. As regards size and proportions, variation is also continuous. *Calophonus* is of large size and with proportionately short tail. Southward, as far as the Golden Gate, as shown by *marinensis* of Humboldt and Marin counties, there is diminution in size. South of this point *spilurus* shows slightly greater dimensions, and, as illustrated by specimens from many intermediate stations, there is steady increase in this regard southward through the range of *charienturus*. Together with increased size southward from the Golden Gate there is correlated a proportionately greater length of tail. In *calophonus*, *marinensis* and *spilurus*, the tail is shorter than the wing. Specimens collected in the region of meeting of *spilurus* with *charienturus* have tail and wing of about equal length, while in typical *charien-*

*urus* the tail is usually decidedly the longer. *Eremophilus*, of the southern deserts, shows still greater extremes of pallid coloration and length of tail. Between *eremophilus* and *charienturus*, where there is a wide gap in distribution except in one limited region, as noted beyond, there can not be traced the nicely graded series of changes found between the other California mainland forms; judging from the imperfectly representative material here assembled from the southern Sierra Nevada (where apparently the ranges of *eremophilus* and *charienturus* closely adjoin), such a condition may be existent in this region. Further collecting here at the proper seasons is necessary to demonstrate this.

Thus on the whole it is seen that the Pacific coast races of *Thryomanes bewicki* may be divided into two general groups, of pale colored, long tailed forms in the arid southwestern region, and dark colored, short tailed forms in the humid northwestern coast region, with maximums of size at the extreme north and south. In every type of variation, connecting chains of intermediates may be traced, corresponding as exactly in geographical position as in extent of variation. *Drymoeus*, as detailed beyond, occupies a central position, almost surrounded by the other mainland forms, and the characteristics of birds of this subspecies vary exactly as the confines of the several contiguous races are approached.

The insular forms of *Thryomanes bewicki* do not exemplify continuous variation such as seen on the mainland. Vancouver Island *calophonus*, in its comparatively paler browns, shows a departure from the mode that does not accord with the general manner of variation of the species in this region. San Clemente Island *leucophrys*, in its gray coloration, might be regarded as exhibiting results of the same nature as are shown in the comparatively gray *Pipilo maculatus clementæ* of the same island. This theory is upset by the fact that on the closely adjacent Santa Catalina Island (lying directly between San Clemente and the mainland), where *Pipilo m. clementæ* also occurs, the representative form of *Thryomanes*, *T. b. catalinæ*, is distinguished from the mainland *charienturus* by slightly darker brown coloration. *T. b. nesophilus* of Santa Cruz and Santa Rosa islands is again differentiated from *charienturus* by slightly darker, more rufescent, coloration.

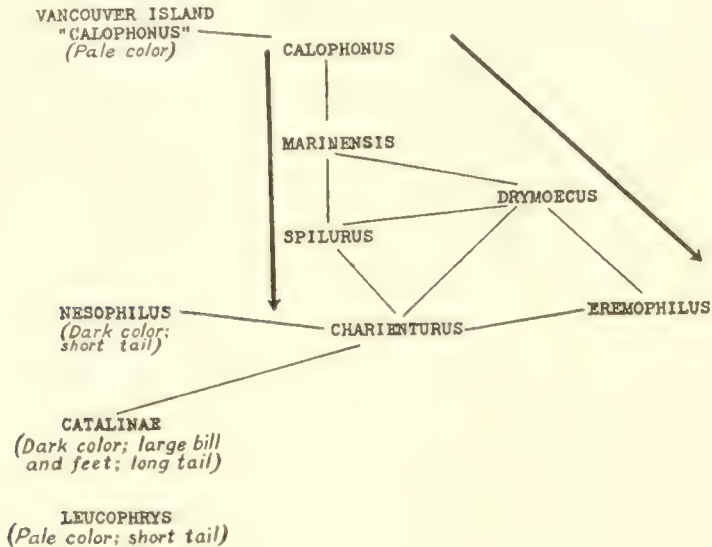
In fact, in the insular forms of *Thryomanes bewicki* (as well as in other races of birds occurring upon the several islands of the Santa Barbara group) it is at present impossible to detect generally uniform results of any factor or factors, either as to the occurrence or non-occurrence of species upon the different islands, or in the amount and nature of differentiation that has taken place.

Possible criticism may be invited by the fact that in the present paper certain local races (subspecies) are pointed out and their characteristics described, but no names affixed. This applies particularly to the Vancouver Island form of *calophonus*, and to the wren of the southern boundary of the Great Basin region as distinguished from typical *eremophilus* of the Gila Basin. It is the writer's opinion that the aggregations of individuals occupying these several areas are geographically separated from the typical forms whose names they bear. They are also probably to be distinguished, though with some difficulty, by the average differences indicated; possibly they are local races in early stages of differentiation. The objections to formally affixing names in their cases are two in number: first, in the slightly distinguished races in question it is impossible to indicate more than obscure average distinctions; and second, the extreme variability shown in individuals of even the most strongly marked of the several described forms militates against the recognition of these apparent geographic variants even though they appear to be isolated. The peculiar characters of the Vancouver Island wren are perhaps to be explained as solely a result of isolation. The Desert Wren of southeastern California, in its departure from typical *eremophilus*, shows a distinct approach to *charienturus*, and it may be that in its affinities, as it is geographically, it is intermediate between the two.

DIAGRAM SHOWING INTER-RELATIONSHIPS OF PACIFIC COAST RACES OF *THRYOMANES BEWICKI*.

Island forms;  
discontinuous variation.

Mainland forms; continuous variation. Dark to light coloration, short tail to long tail.



DETAILED DISCUSSION OF CALIFORNIA RACES

*Thryomanes bewicki marinensis* Grinnell.

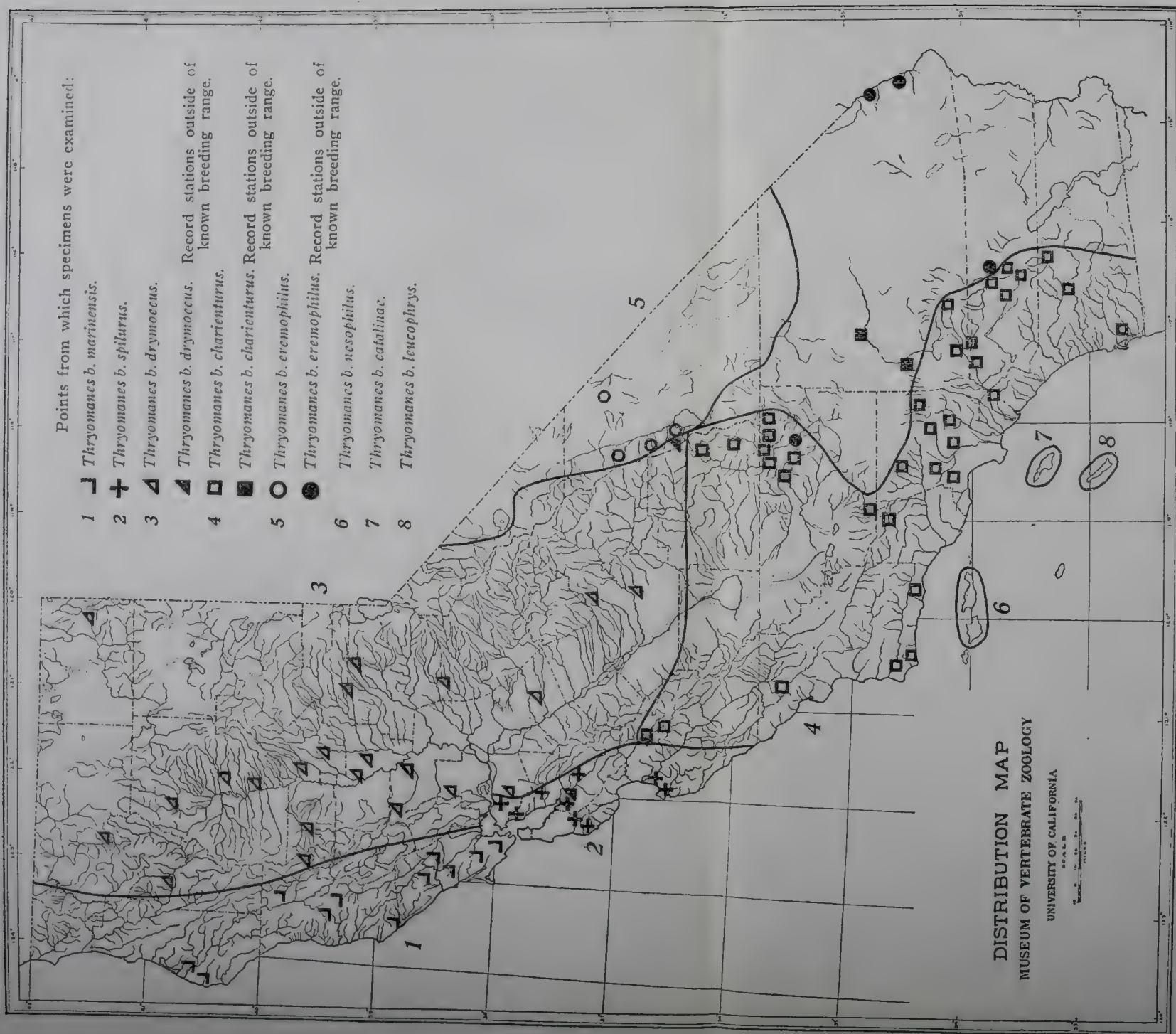
*Type locality*—Nicasio, Marin County, California.

*Range*—The humid coast belt north of the Golden Gate, at least to Humboldt Bay; probably to the Oregon line.

Specimens examined from the following localities: Humboldt County: Capetown, 1; Ferndale, 1. Mendocino County: Covelo, 7; Sherwood, 3; Willits, 1; Gualala, 3. Sonoma County: Guerneville, 5; Freestone, 2; Fulton, 1. Marin County: San Geronimo, 14; Nicasio, 3; Inverness, 8. Total, 49.

*Distinguishing characters*—Similar to *T. b. spilurus*, of the coast region immediately south of San Francisco Bay, but dorsal coloration appreciably darker. Compared with *calophonus* as represented on Vancouver Island, *marinensis* is

Run	Time (min)	Temp (°C)	Pressure (mm Hg)	Flow (ml/min)	Concn (mg/ml)	Yield (g)	Yield (%)
1	10	120	1.0	1.0	1.0	1.0	100
2	20	120	1.0	1.0	1.0	1.0	100
3	30	120	1.0	1.0	1.0	1.0	100
4	40	120	1.0	1.0	1.0	1.0	100
5	50	120	1.0	1.0	1.0	1.0	100
6	60	120	1.0	1.0	1.0	1.0	100
7	70	120	1.0	1.0	1.0	1.0	100
8	80	120	1.0	1.0	1.0	1.0	100
9	90	120	1.0	1.0	1.0	1.0	100
10	100	120	1.0	1.0	1.0	1.0	100
11	110	120	1.0	1.0	1.0	1.0	100
12	120	120	1.0	1.0	1.0	1.0	100
13	130	120	1.0	1.0	1.0	1.0	100
14	140	120	1.0	1.0	1.0	1.0	100
15	150	120	1.0	1.0	1.0	1.0	100
16	160	120	1.0	1.0	1.0	1.0	100
17	170	120	1.0	1.0	1.0	1.0	100
18	180	120	1.0	1.0	1.0	1.0	100
19	190	120	1.0	1.0	1.0	1.0	100
20	200	120	1.0	1.0	1.0	1.0	100
21	210	120	1.0	1.0	1.0	1.0	100
22	220	120	1.0	1.0	1.0	1.0	100
23	230	120	1.0	1.0	1.0	1.0	100
24	240	120	1.0	1.0	1.0	1.0	100
25	250	120	1.0	1.0	1.0	1.0	100
26	260	120	1.0	1.0	1.0	1.0	100
27	270	120	1.0	1.0	1.0	1.0	100
28	280	120	1.0	1.0	1.0	1.0	100
29	290	120	1.0	1.0	1.0	1.0	100
30	300	120	1.0	1.0	1.0	1.0	100
31	310	120	1.0	1.0	1.0	1.0	100
32	320	120	1.0	1.0	1.0	1.0	100
33	330	120	1.0	1.0	1.0	1.0	100
34	340	120	1.0	1.0	1.0	1.0	100
35	350	120	1.0	1.0	1.0	1.0	100
36	360	120	1.0	1.0	1.0	1.0	100
37	370	120	1.0	1.0	1.0	1.0	100
38	380	120	1.0	1.0	1.0	1.0	100
39	390	120	1.0	1.0	1.0	1.0	100
40	400	120	1.0	1.0	1.0	1.0	100
41	410	120	1.0	1.0	1.0	1.0	100
42	420	120	1.0	1.0	1.0	1.0	100
43	430	120	1.0	1.0	1.0	1.0	100
44	440	120	1.0	1.0	1.0	1.0	100
45	450	120	1.0	1.0	1.0	1.0	100
46	460	120	1.0	1.0	1.0	1.0	100
47	470	120	1.0	1.0	1.0	1.0	100
48	480	120	1.0	1.0	1.0	1.0	100
49	490	120	1.0	1.0	1.0	1.0	100
50	500	120	1.0	1.0	1.0	1.0	100
51	510	120	1.0	1.0	1.0	1.0	100
52	520	120	1.0	1.0	1.0	1.0	100



Distribution in California of the Subspecies of *Thryomanes bewickii*.

closely similar in coloration; compared with *calophonus* as represented on the coast of Washington and Oregon, it is brighter and less sooty. In size and proportions, intermediate between *calophonus* and *spilurus*, though nearer the latter.

*Remarks*—The wrens of the northern coast region of California present certain peculiarities of appearance which were commented upon, first by Oberholser (1898, p. 440), and later by Ridgway (1904, p. 565, footnote). The race *marinensis* was formally described by Grinnell (1910, p. 307) upon the basis of these same peculiarities.

There have been available for comparison in the present connection, besides the series of the several California subspecies, 18 skins of *calophonus* from Vancouver Island, and 10 from the mainland of the Puget Sound region of Washington and Oregon. Inspection of these series develops several interesting points in regard to the wrens of the northwestern coast region in general. Judging from the material at hand it seems evident that *calophonus* does not occur in California, unless it is to be found on the coast of the extreme northwestern corner of the state, from which point there are at this time no specimens available. Furthermore, in the range of country at present ascribed to *calophonus*, there appear to be two distinct types existent, lumped under the one name, races which eventually may have to be separated in nomenclature. Specimens from the mainland of Washington and Oregon, which may be considered as typical of *calophonus*, present the extreme of dark coloration in this species. Vancouver Island birds are distinctly paler and more reddish, though of practically the same size. Thus there is the dark colored mainland *calophonus* situated between the Vancouver Island (unnamed) form to the northward, and *marinensis* to the southward, these latter two being paler colored and more reddish, and practically alike in coloration.

To put it a little differently: Beginning at the northern limit of the range of *Thryomanes bewicki* on the Pacific Coast, there is first, on Vancouver Island, a dark, reddish-colored bird of relatively large size. Immediately to the southward, on the mainland of the Puget Sound region, there is an appreciably darker, more sooty form (typical *calophonus*), of

approximately the same size. South of this, along the northern coast of California southward to the Golden Gate, is *marinensis*, paler colored again, practically the same color as the Vancouver Island bird, but smaller. *Spilurus*, from south of San Francisco Bay, is still paler but a trifle larger, gradually merging, both in color and size, into the larger and more pallid *charienturus* of southern California.

The two birds at hand from the vicinity of Humboldt Bay are typical of *marinensis*. They are like the average of Marin County birds, and are correspondingly unlike *calophonus* of the mainland farther north. In the series from Marin and southern Mendocino counties there are several notably pale colored specimens. A female from San Geronimo (no. 2158, Mailliard coll.) is quite grayish above, and there are several juvenals from southern Mendocino County also aberrantly colored. Such a bird is mentioned by Ridgway (1904, p. 565, footnote), from Nicasio; so altogether, it evidently is not uncommon to encounter such pale colored individuals at this point. This is at once suggestive of exactly similar conditions found prevailing among the bush-tits (*Psaltriparus*) of the region (see Swarth, 1914, pp. 513-515), and it would seem that in both instances the phenomena are to be explained in the same way.

The conditions described as probably explanatory in the case of the bush-tit are as follows: "Marked restriction of territory appropriate to the humid coast races, ineffective barriers interposed against complementary forms of much greater numbers occupying adjacent territory, and continual encroachment of individuals (the radiating overflow) of the latter subspecies" (Swarth, *loc. cit.*). The genus *Thryomanes* appears to offer a parallel instance, though to not so marked an extent as in *Psaltriparus*. Aberrant individuals occur as mentioned above, in a manner similar to that observed in the latter genus, but not so numerously.

A series of juvenals from Marin County is appreciably less bright reddish above than is the case in young birds of *spilurus* from Palo Alto. A series of juvenals from Mendocino County contains several pale colored individuals, more nearly approaching the coloration of *drymoccus*.

*Thryomanes bewicki spilurus* (Vigors)

*Type locality*—Near San Francisco or Monterey, California.

*Range*—Coast region of central California (Santa Cruz faunal district); southern and eastern sides of San Francisco Bay, south to southern end of Monterey Bay. Restricted to the region west of the Coast Range.

Specimens examined from the following localities: Contra Costa County: Martinez, 1. Alameda County: Berkeley, 3; Oakland, 7; Piedmont, 2; Alameda, 1; San Lorenzo, 1; Haywards, 2. San Mateo County: La Honda, 1; Woodside, 2; Pescadero, 2. Santa Clara County: Palo Alto, 24; Milpitas, 1. Monterey County: Pacific Grove, 3; Monterey, 1. Total, 51.

*Distinguishing characters*—Most nearly like *T. b. marinensis*, whose range adjoins that of *spilurus* at the north, but of lighter brown coloration dorsally, and of slightly greater size. Compared with *drymoecus* it is brighter reddish above. From *charienturus* it differs in deeper red coloration, and in different proportions. In *spilurus* the tail is slightly shorter than the wing; in *charienturus* the tail is longer than the wing.

*Remarks*—*Thryomanes bewicki spilurus*, as here restricted, ranges over a limited area in the central coast region of California between San Francisco and Monterey bays. Geographically it occupies a position between *marinensis* and *charienturus*, and analysis of the characters of *spilurus* demonstrates that in this latter respect also it is a transitional step between the races to the northward and to the southward. Palo Alto specimens present the best manifestation of the characters of *spilurus* of any of the series at hand. These birds are quite uniformly bright reddish above, the only exceptions being two or three individuals, rather duller colored, and apparently verging toward *drymoecus*.

Birds from the east shore of San Francisco Bay (Berkeley, Oakland, etc.) present a certain peculiarity of coloration, for with hardly an exception they are extremely dark and sooty in appearance, as remarked by Oberholser (1898, p. 439). This is undoubtedly partly, but not altogether, due to smoke stain, the darkening effect of which has been noted in certain

other species at these points. I am inclined to class the birds of this region as representing an intergradient stage between typical *spilurus* of the coast region and *drymoeus* of the interior. The plumage, normally of a less bright rufescence than in the former, is still further modified by the action of the smoke, producing the extremely dark effects seen in the specimens at hand. Of the available skins from the east side of San Francisco Bay, practically all were secured at suburban points in the various towns, where they would be subject to the effects of the smoke of the communities. There is one specimen in the series that forms a striking exception to the above remarks. This is no. 4284, coll. Mus. Vert. Zool., collected by Dr. J. G. Cooper, at Martinez, Contra Costa County, December 15, 1863. This bird is bright, clear reddish above, closely similar to certain of the Palo Alto specimens, and even brighter colored than many from that point. It shows no sign of smoke stain. This latter fact may possibly be due to the fact of there being less smoke in the atmosphere in this general region at that early date.

There are in the series four specimens from the vicinity of Monterey Bay, three from Pacific Grove and one from Monterey. This is too small a series to draw conclusions from, but one of these birds (coll. J. & J. W. Mailliard, no. 4691) displays what appears to be a distinct trend toward the coloration of *charienturus*.

*Thryomanes bewickii drymoeus* Oberholser

*Type locality*—Baird, Shasta County, California.

*Range*—The central portion of California; the Sacramento Valley, and northward at least to the Oregon boundary; northeast to the Warner Mountains, on the Nevada boundary; the west slope of the central Sierra Nevada, everywhere below Transition; southward over about the northern half of the San Joaquin Valley. Specimens from the east slope of the Sierra Nevada at Carroll Creek, taken in September, may have been wanderers from the west side of the mountains, and not necessarily within the normal breeding range.

Specimens examined from the following localities: Modoc County: Cedarville, 2; Sugar Hill, 1. Trinity County: Hel-

ena, 1. Siskiyou County: Callahan, 2. Shasta County: Baird, 1. Tehama County: Tehama, 5; Tuscan Springs, 1. Glenn County: Winslow, 1. Colusa County: Stony Ford, 2. Butte County: Chico, 3; Oroville, 2. Sutter County: West Butte, 2; Sutter, 5. Yolo County: Grand Island, 1; Rumsey, 3. Solano County: Vacaville, 11. Amador County: Carbondale, 2. Nevada County: Cherokee, 4; Montezuma Hill, 2. Placer County: Blue Canyon, 1. Inyo County: Carroll Creek (east slope of the Sierras), 4. Fresno County: Lane Bridge, 1. Madera County: Raymond, 2. Stanislaus County: Modesto, 7. Mendocino County: Mount Sanhedrin, 1. Contra Costa County: Walnut Creek, 8; Mount Diablo, 6. Santa Clara County: Palo Alto, 1. Total number of specimens, 82.

*Distinguishing characters*—Compared with *charienturus*, *drymoecus* has the upper surface darker and more rufescent. The tail is somewhat shorter, and in different proportion to the wing. In *charienturus* the tail is slightly longer than the wing, in *drymoecus* slightly shorter. Compared with *spilurus*, the upper surface of *drymoecus* is a duller and less rich brown. In the juvenal plumage the character of intensity of rufescence of the upper surface is also apparent, young of *drymoecus* being less deeply colored than young of *spilurus* and *marinensis* on the one hand, and somewhat darker (though slightly so) than the young of *charienturus* on the other. It is noteworthy in this regard that whereas in typical *drymoecus* (Sacramento Valley birds) the adults approach *spilurus* more nearly than they do *charienturus*, the juvenal plumage is but slightly different from the same stage in *charienturus*.

*Remarks*—Of the available material of this form, the greater part consists of summer adults in rather worn plumage, with a good proportion of juvenals. There is a lack of birds in fresh fall plumage.

*Thryomanes bewicki drymoecus* is a composite race, and one probably not subject to exact definition. It differs from all the other California forms of *Thryomanes* in the nature of its geographical position, being centrally placed and apparently intergrading with each of the surrounding races at the various points of contact. Consequently birds from different re-

gions exhibit a diversity of appearance that renders it difficult in the extreme to frame a satisfactory characterization of the race, and in places the dividing lines must be somewhat arbitrarily drawn.

Birds from the Sacramento Valley exhibit the best manifestation of the characters of the subspecies. These characters consist of decidedly reddish dorsal surface (though not so rich a red as in *marinensis* and *spilurus*) and short tail, bearing a different relation to length of wing than is seen in *charienturus* and *eremophilus*. Thus in the last analysis the form *drymoeccus* is seen to be an intergradient between the long-tailed, pale colored, southern and desert races, *charienturus* and *eremophilus*, and the short-tailed, richly colored, coastal subspecies, *marinensis* and *spilurus*. This is so markedly the case that while in the Sacramento Valley *drymoeccus* may be considered a fairly well marked form, just as this center is departed from so is there encountered a variation of characters tending toward whichever of the other subspecies is approached.

There is at hand one adult from Baird, Shasta County, California, the type locality of *T. b. drymoeccus*. There are also available one from Trinity County and two from Siskiyou County, all in the same general region in north central California. As indicated by this small series the birds from this part of the state seem to belong to the subspecies *drymoeccus*.

Warner Mountain District. There are one adult and two in juvenal plumage from the Warner Mountains, in the extreme northeastern corner of California. The old bird is decidedly gray, as compared with Sacramento Valley specimens, but the two young ones are even more rufescent than are comparable examples from the latter locality. The dull color of the adult is so noticeable as to suggest the possibility of the existence of a definable local race in this little known portion of the country, but in view of the manner of variation shown by *drymoeccus* in others of the outlying parts of its range, I prefer at present to regard this specimen as another example of the variability of the form. In this connection it may be well to call attention to the possibility that the wren recorded from Camp Harney, southeastern Oregon, by Bendire (1877,

p. 113), and tentatively referred to *eremophilus* by Oberholser (1898, p. 429), may well be of the same race as the Warner Mountain bird.

Sacramento Valley. Thirty-eight specimens from the following counties: Tehama, Glenn, Butte, Colusa, Sutter, Yolo, Solano, and Amador. Of this series 25 are adults, the remainder in juvenal plumage. They were collected during spring and summer, from early March until the middle of July, hence the adults are all in rather worn plumage. Despite this wear, however, these specimens uniformly exhibit to a marked extent the characteristic reddish dorsal surface of the subspecies. As indicated above Sacramento Valley birds may be regarded as typically representative of the interior form, *drymoccus*.

San Joaquin Valley. Birds from this valley are not so easily or satisfactorily disposed of. Both Oberholser (1898, p. 437) and Ridgway (1904, p. 563) have included this region in the habitat of *drymoccus*, but the former author at least had no examples from this valley, as shown by his list of the localities from which specimens were examined. The region is not satisfactorily represented in the series now available, but there is at hand a series of seven skins from Modesto, Stanislaus County (Mailliard coll., nos. 6987, 6993, 7125, 7333, 7385, 7386, 7400), two specimens from Raymond, Madera County (Mus. Vert. Zool., nos. 19,688, 19,689), and one from Lane Bridge, near Fresno (Mus. Vert. Zool., no. 19,687). All of these points are in the east central portion of the San Joaquin Valley. Of these the Modesto birds were collected in January, February, March, and May, the Lane Bridge and Raymond examples in April. Some of them are breeding birds, and the probabilities are that the January and February specimens are also examples of a resident form. At any rate peculiarities of appearance can hardly be explained on the ground that the birds are wandering examples of *charienturus*, for this more southern form would hardly be found represented by individuals wintering so far north of their summer home. On the other hand, these San Joaquin Valley birds are too unlike Sacramento Valley *drymoccus* to be regarded as southward traveling visitants from that region.

So, on the whole, the series may safely be considered as representing the form breeding in this same general region. In coloration the whole series is quite uniform and but slightly distinguished from *charienturus*, being more nearly like this race than like Sacramento Valley *drymoecus*. In measurements the birds stand about midway between the two forms, though rather nearer the latter (see table). All things considered, I have regarded these birds as illustrating intergradation between typical *drymoecus* and *charienturus*, and as representing about the extreme southern valley locality which the name *drymoecus* may be used to cover.

Sierra Nevada. There are six spring birds from Nevada County. Two are from Montezuma Hill, taken March 30, and four from Cherokee, April 5 and 7. From these dates they may fairly be assumed to be representative of the breeding bird of the region. In coloration they closely approach Sacramento Valley *drymoecus*, though they are not quite so reddish; in measurements and proportions there is no difference.

There are at hand four immatures in fresh winter plumage: a male, Blue Canyon, Placer County, October 21; two males and a female, Carroll Creek, east slope of Sierra Nevada in Inyo County, September 11 and 12; all collected at altitudes from 5000 to 7500 feet. A difficulty arises in the proper weighing of the characters of these birds, in that they were evidently late summer wanderers from lower altitudes, from just where, it is impossible to say.

The Blue Canyon specimen (Mus. Vert. Zool., no. 23,295) is dark reddish above, widely different from autumnal *charienturus*, but not so readily distinguished from fall specimens of *marincensis*. It is presumably typical of the fall plumage of *drymoecus* as occurring in the central Sierra Nevada. The three birds from Carroll Creek (Mus. Vert. Zool., nos. 20,858, 20,859, 20,866) are quite different in appearance. They are but slightly reddish above, and with a grayish cast not seen either in *charienturus* or in typical *drymoecus*. As to the precise region occupied by these latter birds during the breeding season, that, of course, is problematical, for they might have wandered even from over the crest of the Sierras; but their appearance leads to the assumption that they represent an ex-

treme southern outpost of Sierran *drymoecus*, where that race abuts on *eremophilus*. The grayish cast of the dorsal surface may well be explained as evidence of intergradation between the two.

From Walnut Creek and Mount Diablo, Contra Costa County, there is a series of two adults and 12 juvenals. The adults, June birds in excessively worn plumage, bear no resemblance to the ruddy colored *spilurus* of the nearby coast region. The young birds, too, lack the clear reddish tone of Palo Alto juvenals, and are very similar to young birds from the Sacramento Valley. The series is unsatisfactory in the lack of fresh plumaged adults, but is apparently to be referred to *drymoecus*, though tending toward the coast form *spilurus*. Birds from the east shore of San Francisco Bay (Berkeley, Oakland, etc.), the nearest point in the range of *spilurus*, are themselves for the most part not typical of that race, so that specimens from this whole general region may be regarded as illustrating intergradation between the coastal *spilurus* and *drymoecus* of the interior. The reference of the Walnut Creek and Mount Diablo birds to *drymoecus* is necessarily based almost wholly upon the appearance of the juvenals. Fortunately there are certain characteristics at this stage, as shown by the large series from the Sacramento Valley, apparently justifying such procedure.

There is one specimen at hand from a point outside of the general breeding range of *drymoecus*, which I feel obliged to refer to this form. This is an immature female (no. 5268, Grinnell coll.) taken at Palo Alto, California, September 27, 1902, and in complete first winter plumage. In color and proportions this bird appears to be unequivocally *drymoecus*. Without conceding any regular migratory habits to the form, it is quite possible for occasional individuals to stray during late summer and fall for as short a distance as is indicated by this capture. I believe this specimen to be such a wanderer from the breeding ground.

The subspecies *Thryomanes bewicki drymoecus* has been denied recognition by the American Ornithologists' Union Committee, and declared to be "not separable from *Thryomanes b. spilurus*" (1901, p. 314). At a later date, in the third edition of the *Check-List* (1910, p. 339), the ascribed range

of *drymoeccus* is included in that of *T. b. charienturus*. Conceding that *drymoeccus* is not as sharply defined a race as certain other forms of the species, still the disposition accorded it under this latter ruling is certainly unsatisfactory, and not tending to assist to an understanding of existing conditions. The wren of the Sacramento Valley is as widely different from *charienturus* of southern California as is the northern coast bird, to which it is more nearly related. If it is not deemed desirable to recognize these slightly differentiated forms in the *Check-List*, a better compromise would be effected by extending the range of *spilurus* to include the Sacramento Valley and central Sierra Nevada, that of *charienturus* to extend through the San Joaquin Valley. Such treatment would be nearer the truth than is the present accepted arrangement; but even so, there would be encountered the difficulties and discrepancies bound to arise in the attempt to define by rigid lines the many fluctuations encountered in the birds of these wide and varied regions.

*Thryomanes bewicki charienturus* Oberholser

*Type locality*—Nashoguero Valley, Lower California (near Mexican and United States boundary line).

*Range*—Coast region of southern California, south from San Benito County and into northwestern Lower California. Breeds mainly on the coastal slope, but in winter is found eastward to the western edges of the Colorado and Mohave deserts, as at Palm Springs, Victorville and Barstow.

Specimens examined from the following localities: San Benito County: Paicines, 13; Mulberry, 4. San Luis Obispo County: Paso Robles, 1. Santa Barbara County: Santa Barbara, 2; Lompoc, 4; Point Conception, 1; Santa Inez River, 1. Ventura County: Mount Pinos, 1; head of Piru Creek, 1. Tulare County: Cannell Meadow, 1; Monache Meadow, 1; Trout Creek, 7. Kern County: Weldon, 3; Onyx, 3; Isabella, 2; Bodfish, 2; Walker Pass, 3; Piute Mountains, 4. Los Angeles County: Pasadena, 91; San Fernando Valley, 19; Santa Monica Mountains, 3; Sierra Madre, 3; Monrovia, 1; San Gabriel Mountains, 6; San Francisco

Canyon, 2; Los Angeles, 7; El Monte, 2. San Bernardino County: San Bernardino Mountains, 5; Cajon Wash, 1; Victorville, 5; Barstow, 1; Reche Canyon, 3. Riverside County: Riverside, 5; San Jacinto Mountains, 28; Valle Vista, 4; Palm Springs, 6; San Geronimo Pass, 1. Orange County: Santa Ana Canyon, 1. San Diego County: San Diego, 1; Witch Creek, 1; Cuyamaca Mountains, 2. Total, 252.

*Distinguishing characters*—Coloration paler, less rufescent dorsally than in any other form of *Thryomanes* from the mainland of California, save *cremophilus*. In fresh fall plumage adults of *charienturus* average close to Saccardo's umber, a color about intermediate between the richer, more rufous, raw umber of *spilurus*, and the grayer hair brown of *cremophilus*. In measurements *charienturus* differs from *cremophilus* in smaller size; from *spilurus*, *marinensis* and *drymoecus* in different proportions, usually having tail longer than wing, whereas in the latter three forms the reverse is the case.

*Remarks*—It is in the relative geographical positions accorded to *charienturus* and *drymoecus* that the results of my observations are most at variance with those of the writers who have previously studied the group. Both Oberholser (1898, p. 437) and Ridgway (1904, p. 563) define the habitat of *drymoecus* as inclusive of the entire San Joaquin Valley, and as extending westward to the coast in San Luis Obispo County. As already stated under *drymoecus*, birds from the central San Joaquin Valley are not typical of that form, being rather of the nature of intergrades toward *charienturus*. Still less are birds from the coast region of San Luis Obispo and Santa Barbara counties to be regarded as representative of *drymoecus*. Such divergence from the mode of *charienturus* as they exhibit appears to be an approach toward *spilurus*, whose territory they border. This, to my mind, is a satisfactory explanation of the slightly more reddish coloration of certain individuals, as well as of the variation in measurements.

Seventeen skins from San Benito County, 13 from Paicines and four from Mulberry, most of them in fresh, unworn plumage, afford excellent comparative material from an intermediate locality, about at the meeting place of the ranges of

*charienturus*, *spilurus* and *drymoccus*. These birds in coloration are practically like southern California *charienturus*, being no more rufescent than are most specimens from that region, and less reddish than birds from the coast of Santa Barbara County. In measurements the San Benito County birds are shorter tailed than is typical *charienturus*, and thus approach *spilurus* or else San Joaquin Valley *drymoccus*. There is very little difference in measurements between these latter two.

There is at hand one skin from San Luis Obispo County and eight from the coast of Santa Barbara County. Some, but not all, of these birds are slightly darker and more rufescent above than *charienturus* from points farther south, but I believe that all are to be referred to that form. It is probably the type of specimen such as I have at hand from San Benito and Santa Barbara counties that formed the basis for the extension of the range of *drymoccus* to these points, but I prefer to regard such birds as illustrating intergradation between *charienturus* and *spilurus*, over the intermediate territory which they occupy. They are with difficulty distinguished from typical *charienturus*, and are certainly quite different in appearance from typical *drymoccus* of the Sacramento Valley.

The excellent series of skins at hand from the coastal region of Los Angeles, San Bernardino and Riverside counties, includes specimens in all stages and from all seasons, and, judging from these, it would seem that the race *charienturus*, as confined to southern California, is as well defined as any of the forms of the genus *Thryomanes*. Here, too, however, there is a certain amount of variation, usually in shade of rufescence dorsally, even in specimens in fresh fall plumage taken at practically the same points; differences that can hardly be explained on any grounds save that they represent the variability existing among individuals of the one race. Segregation according to age or sex yields no uniform or satisfactory divisions.

In the series at hand there are six winter birds from points at the western edge of the Mohave Desert, five from Victorville and one from Barstow. These specimens have been recorded as *drymoccus* (Mailliard and Grinnell, 1905, p. 101; Grinnell, 1901, p. 70), but I am unable to distinguish them

from Pacific Slope *charienturus*, and believe that they are probably wanderers from the nearby San Bernardino Mountains. Midwinter specimens from Palm Springs, at the western edge of the Colorado Desert, belong in a similar class, of winter visitants from the adjacent San Jacinto Mountains.

There is available a series of 23 skins from the southern Sierra Nevada, in Tulare and Kern counties. Of these, 14 are juvenals, while the nine adults are in midsummer plumage, so frayed and faded as to be of little value for color comparisons. It is evident, however, that this series is not to be referred to *drymoecus*, and at present it seems best to include it under *charienturus*. The young birds are decidedly less reddish than juvenals of *drymoecus*, averaging closely similar to young *charienturus*. The variability shown among them tends toward grayish extremes, certain individuals being even paler colored than the average of *cremophilus*. The adults closely approach *charienturus* in similarly worn plumage, and in measurements and proportions also approximate this form.

There are at hand, fortunately, three adults in fresh, unworn plumage, taken in December in the Piute Mountains, at the southern extremity of the Sierra Nevada. These birds are unequivocally *charienturus*, and I believe it is fair to assume that they represent the resident form of this region. Altogether the available material is sufficient to justify the statement that the wren of the extreme southern Sierra Nevada is not *drymoecus*. At first it seemed questionable as to whether or not the birds were representative of *eremophilus*, which breeds on the east slope of the Sierras a short distance to the northward. The juvenals, as noted above, tend toward an extreme of grayish coloration, while the faded adults have something of the appearance of the Desert Wren. Also the presence in the series of an undoubted example of *eremophilus* from the Piute Mountains in September tended to obscure the facts, but this bird in all probability was a migrant from the desert regions to the eastward.

Fresh plumaged *Thryomanes* from the Sierra Nevada of Kern and southern Tulare counties are desirable, and it may be that such will exhibit characteristics intermediate between typical *charienturus* and *cremophilus*.

*Thryomanes bewicki nesophilus* Oberholser

*Type locality*—Santa Cruz Island, California.

*Range*—Santa Cruz and Santa Rosa islands, California.

Specimens examined from the following locality: Santa Cruz Island, 19 (14 adults, 5 juvenals).

*Distinguishing characters*—Most nearly like *T. b. charienturus* of the adjacent mainland, from which it is but slightly differentiated. In coloration the dorsal surface and flanks are of a somewhat darker brown than is the mode in the mainland form. Tail usually shorter than wing; in just one of the adults at hand is it the reverse. In *charienturus* the tail is generally longer than the wing.

*Remarks*—The Santa Cruz Wren is apparently one of the most illy defined of any of the described forms of *Thryomanes bewicki*. The available series affords satisfactory material for comparison, containing four September specimens in newly acquired winter plumage, others taken in early spring, before becoming excessively worn, and some juvenals. Judging from these specimens this island form has become but slightly differentiated from the mainland race. I am able to appreciate the average slightly darker coloration of upper surface and flanks, but it is covered in the range of variation shown by mainland *charienturus*, occasional individuals of the latter being quite as dark.

The difference in proportions is perhaps the most tangible character, for the proportionately shorter tail of *nesophilus* is evident upon measurement. It is perhaps noteworthy that the slight differences serving to distinguish *nesophilus* from *charienturus* are steps in the direction of *spilurus*, the slightly more reddish dorsal coloration, darker flanks, and shorter tail, being just the characteristics encountered in birds occupying the intermediate coastal region between the ranges of *charienturus* and *spilurus*. The mainland nearest to Santa Cruz Island forms part of this intermediate region.

*Thryomanes bewicki catalinae* Grinnell

*Type locality*—Avalon, Santa Catalina Island, California.

*Range*—Santa Catalina Island, California.

Specimens examined from the following locality: Santa Catalina Island, 14.

*Distinguishing characters*—Closely similar to the mainland form *charienturus*, but averaging slightly darker dorsally, and with somewhat heavier bill and feet.

*Remarks*—The peculiarities of the Santa Catalina Island Wren had been already commented upon (Oberholser, 1898, p. 436) before Grinnell (1910, p. 308) affixed a name to the race. The differences distinguishing this form from *charienturus* of the neighboring mainland, however, are but slight, barely sufficient to indicate average distinctions in series from the two regions. Of the skins at hand, 13 are adults, mostly in winter plumage, fresh and unworn. These show the color difference claimed for the race, as well as differences of proportions, and, admitting that these differential characters are not trenchant, still they exist, and their existence justifies the use of a separate name, especially in an insular form.

*Thryomanes bewicki leucophrys* (Anthony)

*Type locality*—San Clemente Island, California.

*Range*—San Clemente Island, California.

Specimens examined from the following locality: San Clemente Island, 23.

*Distinguishing characters*—In coloration *leucophrys* is noticeably grayish as compared with the darker colored neighboring races, *catalinae*, *nesophilus* and *charienturus*. In its pale color *leucophrys* thus approaches *eremophilus*, but is easily distinguishable by size and proportions; *leucophrys* has shorter wings and tail, and longer bill. It also has tail shorter than wing, while in *eremophilus* the reverse is true. The broader superciliary stripe of *leucophrys* is diagnostic.

*Remarks*—The San Clemente Wren is a strongly marked form presenting various points of difference easily appreciated by the most casual observer. The generally pale coloration is apparent in the juvenal as in the adult plumage, and the broader and more conspicuous superciliary stripe is also a feature in the juvenal plumage.

The series available contains 10 adults and 13 juvenals. The adults are all spring and summer birds, more or less worn and faded, there being no fresh autumnal specimens in the lot. Fall birds are probably more rufescent.

*Thryomanes bewicki cremophilus* Oberholser

*Type locality*—Big Hatchet Mountains, Grant County, New Mexico.

*Range in California*—The part of California known to be occupied by this form during the breeding season is limited to the higher mountains of the desert regions of the eastern part of the state in Inyo and Mono counties, and on the east slope of the Sierra Nevada from Lone Pine Creek an undetermined distance northward. In winter it occurs over the breadth of the Mohave and Colorado deserts, westward to the Piute Mountains and to Palm Springs.

Specimens examined from the following localities: California. Inyo County: Inyo Mountains, 2; Kearsarge Pass, 1; Lone Pine Creek, 1; Little Cottonwood Creek, 1. Kern County: Piute Mountains, 1. Riverside County: Palm Springs, 1. Colorado River between Needles and Riverside Mountain, 9. Arizona: Fort Mohave, 3; Huachuca Mountains, 33; Chiricahua Mountains, 6; Fort Lowell, 13; Santa Cruz River near Tucson, 1. Total, 72.

*Distinguishing characters*—Largest of the California forms of *Thryomanes* (see table). Tail longer than wing. Coloration pallid, the palest colored of the California subspecies of the genus.

*Remarks*—The series here accumulated from different points in southeastern California presents certain peculiarities of appearance that suggest the possibility of these birds representing a form recognizably distinct from typical *eremophilus*. In general the California birds appear to be slightly darker dorsally and on the flanks, and slightly smaller, with proportionately shorter tail. Also in the California birds the ground color of the black-barred central rectrices is usually brownish, where in specimens from Arizona it is more decidedly gray; in the California birds there is a tendency toward a dusky, un-

MEASUREMENTS IN MILLIMETERS (AVERAGE, MINIMUM AND MAXIMUM) OF PACIFIC COAST RACES OF  
*THRYOMANES BEWICKI*

	WING	TAIL	CULMEN	TARSUS	Middle Toe without Claw
<i>Thryomanes b. calophonus</i> 7 males, Vancouver Island, British Columbia. ....	53.0 (51.5-54.2)	51.0 (47.0-54.0)	14.8 (14.0-15.5)	19.3 (18.0-20.0)	13.0 (13.0-14.0)
9 males, coast of Washington and Oregon. ....	52.1 (50.0-55.0)	52.0 (49.0-55.5)	14.8 (14.0-15.5)	19.1 (18.5-20.0)	13.3 (12.5-14.0)
<i>Thryomanes b. maritensis</i> 10 males, Humboldt and Marin counties, California. ....	50.5 (48.5-52.0)	49.0 (46.5-51.0)	14.1 (13.0-15.5)	19.0 (18.0-20.0)	12.1 (11.0-13.2)
<i>Thryomanes b. spiliurus</i> 10 males, San Francisco Bay and Monterey Bay, Cal. ....	51.9 (50.5-53.5)	50.9 (50.0-52.2)	14.3 (13.5-15.0)	18.5 (17.2-19.5)	11.7 (11.0-13.0)
<i>Thryomanes b. charienturus</i> 10 males, Riverside and Los Angeles counties, Cal. ....	52.4 (50.5-55.5)	53.6 (50.2-56.0)	14.9 (14.0-15.5)	18.7 (18.0-19.5)	11.7 (10.5-12.0)
<i>Thryomanes b. drymoecus</i> 10 males, Sacramento Valley, California. ....	51.6 (50.0-53.5)	49.3 (47.5-54.0)	14.4 (13.5-15.2)	18.4 (18.0-19.2)	12.1 (11.5-13.0)
7 adults (6 males, 1 female), central Sierra Nevada, California. ....	51.2 (50.0-54.0)	49.7 (47.5-53.0)	14.3 (14.0-15.0)	18.3 (18.0-18.8)	12.2 (12.0-12.5)
7 males, San Joaquin Valley, California. ....	53.1 (50.2-55.0)	51.4 (48.0-53.5)	14.4 (13.5-15.5)	18.7 (18.0-19.2)	12.3 (11.5-13.0)
<i>Thryomanes b. eremophilus</i> 10 males, southeastern California. ....	55.2 (54.0-58.0)	56.9 (52.0-61.0)	13.6 (12.0-15.0)	18.1 (17.0-19.2)	11.5 (11.0-12.0)
10 males, Huachuca Mountains, Arizona. ....	57.1 (56.0-59.0)	57.7 (53.5-60.5)	13.9 (13.2-15.0)	18.1 (17.0-19.0)	12.0 (11.0-12.5)
<i>Thryomanes b. catalinae</i> 7 males, Santa Catalina Island, California. ....	53.2 (52.0-55.0)	54.2 (52.0-56.5)	15.2 (14.5-16.0)	19.5 (18.0-20.0)	12.8 (12.0-13.5)
<i>Thryomanes b. nesophilus</i> 10 males, Santa Cruz Island, California. ....	52.8 (51.0-55.5)	51.7 (48.0-56.0)	14.7 (14.0-15.2)	19.1 (18.2-19.8)	11.9 (11.0-13.0)
<i>Thryomanes b. leucophrys</i> 8 males, San Clemente Island, California. ....	52.1 (50.0-53.8)	49.4 (46.5-52.5)	14.7 (14.0-15.5)	19.2 (18.5-20.0)	12.3 (12.0-13.0)

barred area at the tip, as shown in a considerable proportion of specimens.

In southeastern Arizona *cremophilus* is a common resident of both the Upper and Lower Sonoran zones, being abundant in the Lower Sonoran river valleys. In eastern California this wren appears to breed only in Upper Sonoran, migrating down into Lower Sonoran in the winter months. It is, I believe, the only California wren of this genus that has truly migratory habits.

That individuals of the species should be found in the valley of the Colorado River, at the western boundary of Arizona, in winter only (Grinnell, 1914, p. 209), while the species is resident the year through in valleys of similar zonal character in the eastern part of the state, argues, it seems to me, that these sets of individuals represent two entirely separate aggregations, two distinct subspecies, if we wish to call them so. Furthermore, observations so far made as regards other species show that the valley of the Colorado does not serve as a winter home for birds from the colder country to the eastward. The transient winter population of this valley seems to come almost entirely from the Great Basin region to the northward, with its surrounding mountains, and it is fair to assume that these winter visiting wrens are also from that region. The slight differential characters apparent, as enumerated above, appear to bear out this assumption.

Personally I believe that there are at least two separate forms included under the term *cremophilus* as now used, one occurring in the Great Basin region of southern Nevada and eastern California, migrating over the Colorado and Mohave deserts in winter, the other represented by the resident bird of southeastern Arizona. Additional material is needed from California, in the nature of fresh autumnal and early spring specimens from breeding stations, more clearly to demonstrate the presence of differentiating characters. In the absence of such material, and bearing in mind the variability shown by the wrens of this genus where different subspecies meet, it seems advisable to refrain from formally affixing a name to the possibly recognizable California race. It is significant in this connection to note that in proportion as California specimens of

*eremophilus* differ from the mode of that subspecies, so do they approach *charienturus* or *drymoecus*.

There is a specimen of the Desert Wren at hand collected in the Piute Mountains, Kern County, September 6, 1903. As noted previously in this paper, under *charienturus*, examples of the latter race were taken in winter in the same mountain range; and circumstances make it appear that *charienturus* is the resident form. With little doubt *eremophilus* is but a migrant or winter visitant at this point. There is at hand another example of this subspecies from Palm Springs, Riverside County, taken December 30, 1903. The Desert Wren thus ranges in winter over the breadth of the Colorado Desert, and probably over the Mohave Desert as well, but it evidently is rare at the western borders of these tracts. Considerable winter collecting at points on the Mohave River, as at Victorville and Yermo, has failed to disclose its presence there, and the one specimen from Palm Springs is the only example recorded from the latter station. Apparently the bottom lands of the Colorado River form the main winter home of the species in this region.

The series of skins from southeastern Arizona contains an excellent representation of both adults and juvenals, taken at all seasons of the year. The individuals of this series, although true in the main to the characteristics of the race, exhibit a certain amount of variation, apparently to be explained only as due to individual peculiarities. This is true of both adults and juvenals. As having bearing upon the extremes of variation encountered, mention might be made of the recorded occurrence of *drymoecus* at Calabasas, southern Arizona (Oberholser, 1898, p. 438). In the series before me there is a single individual taken in the Chiricahua Mountains, Arizona, October 27, 1914 (no. 2538, coll. of J. E. Law), that might be considered as belonging in the same category. This last mentioned bird is short tailed and rather dark colored, being not unlike certain examples of *drymoecus* in appearance, while it is even darker colored than selected specimens of *charienturus*. While this specimen in certain respects thus bears a casual resemblance to some California birds rather than to typical *eremophilus*, I cannot believe that it belongs to the race *drymoecus*, in the sense that this is an individual

that has actually traveled from central California to southeastern Arizona. Such action would be so remarkably at variance with all known conditions prevailing among the subspecies of *Thryomanes* of the central valley and coast regions of California that I do not for a moment consider that it is to be taken into account in explaining this circumstance.

As affording additional evidence to the contrary, there is in my series a molting bird taken in the Huachuca Mountains, Arizona, August 17, 1902 (no. 3082, Swarth coll.). This specimen, covered with pin feathers, and with rectrices and remiges but partly grown, is assuming a dorsal coloration far more rufescent than the average of *eremophilus*, freshly molted birds being used in comparison, and it is closely similar to the Chiricahua Mountain bird just described. Yet there can be but little doubt that this individual was in its summer home when captured, and that it is representative of an extreme of color variation occasionally reached in the subspecies *eremophilus*.

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PROCEEDINGS  
OF THE  
CALIFORNIA ACADEMY OF SCIENCES  
FOURTH SERIES

VOL. VI, No. 5, pp. 87-128.

MAY 8, 1916

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V

MONOGRAPH OF THE NORTH AMERICAN SPECIES  
OF ORTHOTYLUS (HEMIPTERA)

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Genus *Orthotylus* Fieb.

In common with other genera of its tribe, the genus *Orthotylus* has the apical margin of the pronotum without a collar; the prosternal xyphus (the triangular plate between the anterior coxæ) with a more or less distinctly carinate margin, its base being flat or convex, and the arolia (the pulvillæ between the tarsal claws) free and converging toward their apex. The following are the more essential characters of this genus:

Head almost vertical; when viewed from above, short, transverse, with the eyes distinctly wider than the anterior margin of the pronotum; when viewed from before, five-angled, but little longer than wide across the eyes. Vertex with a basal carina and before it a depressed line or area. Front convex; clypeus prominent, its base usually on a line with the base of the antennæ. Facial angle (angle between the line of the clypeus and that of the bucculæ) a right angle. Eyes prominent, viewed from the side ovate, placed a little oblique or

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nearly vertical; when viewed from above nearly round or more or less flattened within. Antennæ pubescent, inserted near or somewhat below the lower angle of the eyes; linear; basal joint thickest, the apical becoming setaceous; the basal joint with two or three longer stiff bristles or setæ within toward its apex. Pronotum trapezoidal, rather flat, usually transverse, but sometimes nearly or quite as long as broad, its converging sides nearly rectilinear and its base feebly arcuated or straight across the scutellum; callosities prominent, usually distant but often connected by an elevated area anteriorly that does not reach their hind margin. Scutellum nearly flat or moderately elevated, its basal lobe often more or less exposed. Elytra normally rather long, considerably surpassing the abdomen. Membrane biareolate. Legs rather long, the hind femora moderately incrassate; tibiæ armed with a few weak spines. Rostrum normally attaining the apex of the intermediate coxæ, becoming black at apex. Oviduct of female short, beginning behind the middle of the venter. Upper surface usually clothed with a fine pubescence or with longer and stiffer hairs, or with both.

Our species of this large and difficult genus may conveniently be grouped in three series:

Group I (*flavosparsus* group). Small, moderately elongated green species with the base of the vertex sharply carinate, the pronotum short, transverse, and the legs comparatively short. Some of the species are clothed with coarse, often flattened, deciduous black hairs. Here belong: *insignis*, n. sp.; *tibialis*, n. sp.; *ferox*, n. sp.; *viridicatus* Uhl.; *coagulatus* Uhl.; *flavosparsus* Sahlbg.; *chlorionis* Say; *fraternus*, n. sp.; *uniformis*, n. sp.; *translucens* Tuck.; *viridis*, n. sp.; *senectus*, n. sp.; *nigrinasi*, n. sp.

Group II (*ovatus* group). Medium sized, oval, pale colored species having much the form of a *Lygus* with the aspect of an *Oncotylus*. These have the base of the vertex obtusely carinate, the pronotum transverse and the legs comparatively short. Here belong *ovatus*, n. sp., and *catulus*, n. sp.

Group III (*dorsalis* group). More elongated or slender species having the base of the vertex sharply carinate preceded by a distinct bidentate transverse depression; the pronotum nearly or quite as long as broad and the legs long and slender. The species of this group are usually pale, marked more or less with fuscous or black, the elytra typically having the clavus and an area on the disk of the corium fuscous or black. Here belong: *formosus*, n. sp.; *modestus*, n. sp.; *dorsalis* Prov.; *marginatus* Uhl.; *molliculus*, n. sp.; *affinis*, n. sp.; *angulatus* Uhl.; *brunneus*, n. subsp.; *cuneatus*, n. sp.; *pullatus*, n. sp.; *languidus*, n. sp.; *lateralis*, n. sp.; *cruciatus*, n. sp.; *submarginatus* Say; *necopinus*, n. sp.; *fumidus*, n. sp.; *ornatus*, n. sp.; *candidatus*, n. sp.

I have been unable to locate *inconspicuus* Uhl. Reuter's description of his *biguttatus* answers almost perfectly to *coagulatus* Uhl. of which it probably is a synonym. Tucker records *diaphanus* Kirschb. from Kansas, but the determination is very doubtful. The present paper includes all other species recorded from America north of Mexico. The following key will locate our species:

- Ground color green, sometimes almost white, dark markings if present not clouding the elytra .....1.
- Ground color pale testaceous to black, sometimes greenish when immature; the elytra in that case marked with fuscous or black areas....14
- 1, Antennæ, tibiæ and tarsi black; ground color a bluish-green; small species (3mm. to tip of abdomen),.....2. *tibialis*, n. sp.
- , Antennæ pale or mostly so,.....2.
- 2, Basal joint of the antennæ marked with black,.....3.
- , Basal joint of the antennæ uniformly pale,.....4.
- 3, Antennæ slightly infuscated, the basal joint green or greenish with its immediate base deep black, .....1. *insignis*, n. sp.
- , Antennæ pale; basal joint biannulate with black; base and apex of second joint fuscous; apex of the head deep black. .13. *nigrinasi*, n. sp.
- 4, Form broader or ovate, somewhat like a small *Lygus*,.....5.
- , Form more slender and parallel,.....6.
- 5, Color a yellowish-green, with the membrane infuscated; the surface clothed with deciduous matted fuscous hairs.....14. *ovatus*, n. sp.
- , Color nearly white; above sparsely dotted with bluish-green in mature examples, .....11. *senectus*, n. sp.
- 6, Membrane black or blackish with the nervures calloused and white at apex; surface clothed with coarse deciduous black hairs,.....4. *viridicatus* Uhl.
- , Membrane sometimes infuscated, the nervures then pale or concolorous, .....7.

- 7, Membrane infuscated at apex, marked with a distinct white spot at tip of the cuneus followed by a blackish cloud and beyond that a pale vitta, sometimes obsolete,.....5. *coagulatus* Uhl.
- , Membrane without alternating black and white markings at tip of the cuneus, .....8.
- 8, Upper surface with minute pale pubescence; apical antennal joints infuscated, .....9.
- , Upper surface with dark fuscous or black pubescence,.....11.
- 9, Smaller (4-4½mm.); first antennal joint thicker, obviously shorter than the head viewed from above; sinistral hook of the male genitalia short, scarcely longer than the dextral,.....10. *translucens* Tuck.
- , Larger (5-5½mm.); first antennal joint obviously as long as the head, .....10.
- 10, Basal joint of the antennæ fulvo-testaceous like the second joint; dextral hook of the male genitalia small, ligulate; sinistral long, curved and acuminate; western, .....9. *uniformis*, n. sp.
- , Basal joint of the antennæ brown, the second fulvo-testaceous; dextral hook of the male genitalia large and broad-triangular; sinistral linear and straight, rather long; eastern,.....12. *viridis*, n. sp.
- 11, Elytra surpassing the abdomen by nearly one-half its length; abdomen in the male reaching to just beyond the base of the cuneus; antennæ and membrane slightly infuscated,.....8. *fraternus*, n. sp.
- , Elytra shorter, the abdomen of the male reaching well toward the apex of the cuneus, .....12.
- 12, Upper surface clothed with deciduous black hairs which are in part flattened and conspicuous; color pale bluish-green; vertex broadly depressed, .....3. *ferox*, n. sp.
- , Upper surface clothed with a less conspicuous vestiture, the hairs not large and flattened; color a yellowish-green; transverse basal depression of the vertex narrow, .....13.
- 13, Areoles of the membrane pale green; elytra with clusters of white hairs intermixed with dark ones,.....6. *flavosparsus* Sahlbg.
- , Areoles of the membrane concolorous; elytra without pale hairs intermixed with the dark ones,.....7. *chlorionis* Say.
- 14, Form ovate as in *Lygus campestris* nearly; color a uniform whitish of fusco-testaceous, head and callosities tinged with yellowish,.....15. *catulus*, n. sp.
- , More elongated species; elytra with fuscous areas more or less marked, or at times entirely black,.....15.
- 15, Color whitish-testaceous, fuscous markings of the elytra very faint or nearly obsolete in the female,.....16.
- , Ground color sometimes pale greenish or yellowish, the dark elytral markings always distinct, or the whole insect may become almost black, .....17.
- 16, Without black markings, the disk of the head and the pronotum behind the callosities sometimes with a faint fuscous cloud in the male; membrane with a faint ray beyond the areole; antennæ pale,.....16. *languidus*, n. sp.
- , Median line of the front, vertex and scutellum, lateral margins of the pronotum and the sides of the body beneath black; membrane slightly infuscated with the nervure brown; antennæ blackish,.....32. *candidatus*, n. p.
- 17, Body uniformly fuscous, the sides of the venter darker; length 6mm., .....34. *humidus*, n. sp.
- , Body never uniformly fuscous, the elytra with at least the costal nervure or a vitta interior to it pale,.....18.
- 18, Elytra with the costal and commissural nervures and base of the cuneus slenderly pale, otherwise fuscous-brown above; length 7mm.,.....33. *necopinus*, n. sp.

- , Elytra with more than the costal and commissural nervures pale; length under 6mm., .....19.
- 19, Costal nervure black with a pale vitta between it and the dark dorsal vitta, or it may be dark on the dark areas without a pale vitta inferior to it, .....31.
- , Costal nervure pale and forming part of a pale costal vitta, .....20.
- 20, Disk of the pronotum pale with the lateral margins covered by a linear black vitta, the pale disk narrowing anteriorly, .....29.
- , Disk of the pronotum sometimes with a broad pale median vitta, but then with the humeral angles and usually the sides pale, .....21.
- 21, Pronotum with the anterior lobe infuscated, the posterior lobe more or less distinctly pale, usually divided by a dark median vitta, .....30.
- , Pronotum with the anterior lobe usually pale, never infuscated with the disk of the posterior lobe pale, .....22.
- 22, Membrane vittate, more or less hyaline with a darker ray beyond the areole, .....23.
- , Membrane uniformly infuscated, without a darker ray beyond the areole, .....24.
- 23, Areole of the membrane hyaline, the vitta beyond the areole evident; color of body clear pale green with a line on the hind margin of the pronotum and a spot behind the callosities black; a vitta on the clavus and spot near the inner angle of the corium fuscous, .....17. *formosus*, n. sp.
- , Areole of the membrane more deeply infuscated than the adjoining surface, body more or less infuscated, the base of the corium, the cuneus and usually the median line of the pronotum pale, .....30. *ornatus*, n. sp.
- 24, Nearly the whole surface including the legs black or blackish, the costal margin, ventral vitta, coxæ and trochanters only pale, .....26. *pullatus*, n. sp.
- , The legs, at least, pale or but little infuscated, .....25.
- 25, Callosities pale or they are the last portion of the pronotum to become invaded with black; vertex often black, when pale without a transverse black mark on either side, .....26.
- , Callosities black or they are the first part of the pronotum to become invaded with black; vertex pale with a transverse black mark on either side, .....28.
- 26, Antennæ black in both sexes; genital hooks of the male pale; the male generally with a pale dorsal vitta on the pronotum, 20. *marginatus* Uhl.
- , Antennæ pale in the female, fuscous or black in the male; genital hooks of the male black, .....27.
- 27, Pronotal markings transverse; when the pronotum is all black the second antennal joint of the male is rufo-testaceous, 18. *modestus*, n. sp.
- , Pronotal markings longitudinal; when the pronotum is all black the second antennal joint of the male is black, .....19. *dorsalis* Prov.
- 28, Smaller (5mm.); body beneath mostly black; front black or mostly so, .....21. *molliculus*, n. sp.
- , Larger (6mm.); body beneath mostly pale; front pale with a black arc either side, .....22. *affinis*, n. sp.
- 29, Smaller (4mm.); second antennal joint short, not longer than the third and fourth together, .....28. *lateralis*, n. sp.
- , Larger (5mm.); second antennal joint long, distinctly longer than the third and fourth together, .....27. *cruciatu*s, n. sp.
- 30, Sutural margin of the corium with a wedge-shaped pale mark, .....23. *angulatus* Uhl.
- , Sutural margin of the corium with a linear pale mark, .....24. *angulatus brunneus*, n. subsp.

- 31, Costal nervure concolorous, dark against the dark areas; elytra blackish, the base of the cuneus and a wedge-shaped mark along the claval suture pale, .....25. *cuneatus*, n. sp.  
 —, Costal nervure black with a pale vitta between it and the black dorsal vitta, .....32.  
 32, Ground color above fulvous or salmon, elytra black, the fulvous border of the corium not attaining the costa, the extreme edge being black,.....31. *submarginatus* Say.  
 —, Elytra black with a subcostal whitish vitta covering most of the cuneus; posterior disk of the pronotum and the legs fulvous,.....29. *knighti*, n. sp.

### GROUP I (Subgenus *Orthotylus* Fieb.)

#### 1. *Orthotylus insignis*, new species.

Larger and more slender than any allied species; elongated or elliptical; bright grass-green becoming yellowish about the head and base of the femora; first joint of the antennæ yellowish with its immediate base conspicuously black, length 5-6mm., width  $1\frac{1}{2}$ mm.

Vertex much depressed posteriorly, leaving the basal carina strongly elevated; front but moderately convex. Eyes prominent, viewed from the side shorter than in the allied forms. Antennæ unusually long, about reaching to the apex of the membrane; basal joint longer than the head in the female, much longer in the male; second joint two and a half times the length of the first; third about two-thirds the length of the second; fourth shorter than the first. Rostrum short, not attaining the apex of the intermediate coxæ. Pronotum short, flat, showing a median carina and lateral carinate margins; deeply impressed around the prominent callosities, thus making the anterior margin appear thickened; sides strongly oblique, the anterior angles broadly rounded. Elytra long, elliptical in the female, the tip of the cuneus scarcely surpassing the tip of the abdomen; in the male nearly parallel, the costal margin very gently arcuated, the corium a little surpassing the tip of the abdomen. Legs unusually long and slender, the tibiæ with a few weak bristles.

Dextral hook of the male genitalia very large, recurved from near its base, where there is an acute projection from the inner angle, the upper member greatly produced in a long curved brown spine-like process almost attaining the opposite

wall of the pygofers; sinistral hook long, white and terete, curved around horizontally concentric with the sinistral wall of the genital segment.

Color a clear bluish-green, becoming yellowish on the head, pronotum and beneath; clothed above with short, black, deciduous hairs; antennæ pale, the base of the first joint narrowly deep black, the apical joints infuscated. Elytra immaculate, the membrane with pale nervures. Tibiæ pale clothed with minute black hairs, the tarsi black.

Described from one male and two female examples taken by me at the upper end of Fallen Leaf Lake, Calif., July 24, 1915. This pretty species is unusually large and slender and in some points is not typical of this genus.

Type, male, in the collection of the University of California. Allotype (No. 301) in the Museum of the California Academy of Sciences. Paratype in collection of the University of California.

## 2. *Orthotylus tibialis*, new species.

Form of *Labopidea nigripes* nearly, but much smaller; bluish-green, conspicuously clothed with black deciduous hairs; antennæ, tibiæ, and tergum black. Length  $4.4\frac{1}{2}$  mm. to tip of membrane.

Head large, vertical; eyes small, bead-like; viewed from the side, short, scarcely surpassing the insertion of the antennæ, narrowed below, little longer than broad. Vertex with a large triangular impressed area; basal carina prominent. Front strongly convex; clypeus small, prominent. Pronotum short, transverse, its length distinctly less than one-half its basal breadth; callosities prominent, elongated. Basal joint of the antennæ longer than the head, much thickened almost to the base; second about three times the length of the first. Elytra of the male long, the costa moderately arcuated, the apex of the abdomen reaching to the tip of the corium. Elytra of the female hardly attaining the apex of the abdomen, the costa well arcuated, giving the insect an ovate form, broadest beyond the tip of the clavus, the membrane but little surpassing the tip of the cuneus.

Dextral hook of the male genitalia broad at base, upcurved and attenuated at apex; sinistral hook short and strap-shaped, lying along the edge of the pygofer.

Color dull bluish-green, conspicuously clothed with coarse black deciduous hairs. Head and lower surface paler. Antennæ, apex of the rostrum and the tibiæ and tarsi deep black; tergum black, becoming green toward the margin.

Described from numerous examples taken about the lower end of Fallen Leaf Lake, near Lake Tahoe, Calif., July, 1915. The conspicuously black tibiæ and antennæ will readily locate this distinct species.

Type, male, and allotype in collection of the University of California. Paratypes in collections of the Museum of California Academy of Sciences (nos. 302-304), University of California and in author's collection.

### 3. *Orthotylus ferox*, new species.

Form and size of *flavosparsus*, nearly; color a pale faded green, clothed with stout black hairs when fresh. Length  $3\frac{1}{2}$  mm. to tip of membrane.

Head short, vertical. Eyes small; viewed from the side, vertical, but little longer than wide, narrowed to an angle below, not reaching much beyond the middle of the side of the head. Vertex broad, basal impression broad and shallow, the basal carina prominent, obtuse, sinuated. Front prominent, convex, its sutures deep; facial angle rounded. Antennæ short; first joint shorter than the dorsal aspect of the head. Pronotum short, transverse, its length about one-half its basal width; sides straight, the angles well rounded; anterior margin concavely sinuated; callosities prominent. Scutellum small, the basal lobe covered. Elytra moderately broad, the costa feebly arcuated. Abdomen passing the middle of the cuneus in the male, nearly attaining the apex in the female. Tibiæ with the longer bristles black. Whole upper surface clothed with coarse appressed black hairs, which are easily rubbed off.

Male genital characters much like those of *tibialis*, but the pieces are less curved and less interlocked; the dextral hook narrower and more acute; the sinistral lying close to the edge of the segment.

Color pale bluish-green with a whitish aspect when denuded. Scutellum, head, lower surface and legs, and sometimes the callosities, yellowish. Membrane faintly fuliginous, the nervures paler. Antennæ infuscated nearly to the base of the second joint, the basal pale. Tibial bristles and apex of the tarsi black.

Described from numerous specimens taken in San Diego County, Calif., as follows: Alpine, March to April; Balboa Park, San Diego, April; El Cajon Valley, May first. This insect has much the aspect of *tibialis* and quite similar genital characters, but the females are less oval and the antennæ are pale instead of black. This and the three following species have the vertex broader with much smaller and less prominent eyes.

Type, male, and allotype in author's collection. Paratypes in Museum of California Academy of Sciences (305, 306), collection of the University of California and in author's collection.

#### 4. *Orthotylus viridicatus* Uhler.

Form of *coagulatus*; clothed above with coarse black deciduous hairs; membrane blackish with the nervures at the apex of the areoles conspicuously white. Length  $4\frac{1}{2}$  mm.

Head smaller than in the allied species with the eyes large and prominent, especially in the males. Vertex flat, distinctly, angularly impressed before the prominent basal carina; front but slightly convex. Clypeus very prominent, its base distinctly below the line of the antennæ. Eyes, viewed from the side, much longer than broad, angled below, reaching over half-way to the gula. Antennæ short, the second joint scarcely longer than the basal width of the pronotum. Pronotum short, transverse; sides scarcely arcuated, the anterior angles well rounded; callosities prominent, convex. Elytra rather short, the abdomen reaching to about the middle of the cuneus in the male, to beyond its tip in the female.

Dextral hook of the male genitalia long protruding, terete, its end rounded and not at all narrowed; sinistral hook broad, curved, parallel with the lower margin of the pygofers, its acute apex curved inward.

Color, a bluish-green in mature examples, becoming yellowish on the callosities and head, and paler beneath; above clothed with deciduous pale hairs intermixed with thick black ones. Vertex and pronotum with a pale median line more or less apparent. Basal joint of the antennæ green, second darker, the third and fourth infuscated. Tibiæ a little darker, the apical half of the tarsi black. Membrane deeply infuscated, the nervures thickened and white below the base of the smaller areole.

The types of this species were from Colorado and New Mexico. I have seen specimens from Idaho and took it in abundance in San Diego County, Calif., during March, April and May, and it was not uncommon about Fallen Leaf Lake, Calif., at lower levels (between 6,000 and 7,000 feet). So far as I can now tell, my material was all taken on the sage brush, *Artemisia*, spp. The blackish membrane marked with conspicuous white nervures will distinguish this pretty species from its nearest relatives.

#### 5. *Orthotylus coagulatus* Uhler.

Size and aspect of *flavosparsus* nearly, but with the head narrower and the eyes larger and more prominent; pale green, clothed with minute whitish pubescence and longer black hairs; membrane with a fuscous spot beyond the areoles. Length  $4\frac{1}{2}$  mm. to tip of the membrane.

Head rather small, viewed from above, acutely angled at apex. Vertex in the female about three times as wide as the eyes; flattened toward the base, leaving the basal carina sharp and prominent across its whole width; in the male narrower, hardly twice as wide as the large eyes, with the base scarcely impressed and the carina less prominent. Clypeus large and very prominent. Antennæ long and slender, the basal joint scarcely as long as the head, surpassing the tylus by one-half its length; third but little shorter than the second. Pronotum short; sides straight or feebly concave in the male; callosities prominent. Elytra moderately long, the tip of the abdomen reaching to the middle of the cuneus in the male, sometimes surpassing its apex in the female.

Dextral hook of the male genital segment short, knob-like; the sinistral large, convex, filling the excavation at the apex of the genital segment; its apex broadly rounded.

Color pale green, becoming yellowish, especially on the head and beneath; the color on the elytra apparently coagulated so as to leave irregular pale spots and marks. Vertex and pronotum sometimes with a continuous pale median line. Antennæ and legs soiled yellowish; the tibial bristles, tips of the tibiæ and apical one-half of the tarsi black. Membrane slightly enfumed at apex; apical inner edge of the larger areole broadly green or fuscous; at the tip of the cuneus is a white area, followed by a distinct fuscous cloud. Upper surface clothed with minute pale pubescence and longer black hairs, all of which are easily rubbed off.

The types were from Colorado. I found it quite common in that state and have taken a few in San Diego County, Calif., at Lakeside and Alpine, and Mr. H. G. Barber has kindly sent me a specimen from the Huachuca Mountains, Arizona, taken July 20. The mottled aspect of the elytra and the variegated membrane will distinguish this species.

#### 6. *Orthotylus flavosparsus* Sahlberg.

Small, oblong-ovate; clear green, becoming yellowish on the callosities, head and lower surface; membrane slightly enfumed, with the surface of the areoles pale green. Length 4mm. to tip of membrane.

Head about as in *viridicatus*, small with the eyes prominent in the male, less so in the female. Vertex flat with a median areolate depression before the prominent basal carina, less conspicuous in the female. Front but moderately convex, the clypeus small with its base rather above the line of the antennæ. Antennæ short, the basal joint unusually short. Pronotum as in the allied species, short and flat with prominent callosities. Elytra short, the apex of the abdomen in the male reaching to the middle of the cuneus, nearly to the apex of the membrane in the female.

Dextral hook of the male genital segment minute, rounded; sinistral rather large, broad at base, much extended outwardly

and acute at apex, the apical margin of the hook truncated across its whole width.

Color, clear green, becoming yellowish on the callosities, head, and lower surface, and the legs and antennæ pale, the latter somewhat infuscated beyond the basal joint; tip of the tibiæ and the tarsi brown or black. Upper surface clothed with black hairs, interspersed with pale buff ones, the latter segregated into roundish spots, giving the insect a mottled aspect when fresh. Membrane slightly evenly infuscated, the nervures and surface of the areoles clear green.

This European species seems to be widely distributed in the east. I have examples from Montreal, Ottawa, Lake Temagami, P. Q., and Ridgeway, Ont., also from New York, New Jersey, District of Columbia, Virginia, Ohio, and Kansas. It may at once be distinguished from its allies by the green surface of its areoles and the peculiar yellowish mottled aspect of the fresh examples.

#### 7. *Orthotylus chlorionis* Say.

Closely allied to the preceding; clear green, clothed above with minute fuscous hairs, but without an intermixture of pale ones, at least in any of the numerous specimens I have seen; membranal areoles concolorous. Length  $3\frac{1}{2}$ -4mm. to tip of the membrane.

Head as in the preceding, but with the vertex and front somewhat fuller; the basal depression of the vertex narrow, ill-defined before, the basal carina prominent. Antennæ short, the first joint shorter than the head. Pronotum short, the sides straight, with the anterior angles well rounded. Callosities bounded by a sharp depressed line behind, not as prominent as in the allied species. Elytra rather short, the abdomen reaching to about the tip of the cuneus in both sexes. Tibial bristles short and weak, not longer than the thickness of the joint.

Male genital pieces very small, the dextral hook hardly more than twice longer than broad, ligulate; sinistral curved, narrow, parallel, lying along the ventral edge of the genital segment.

Color a uniform clear green, becoming yellowish on the callosities, head and beneath. Antennæ and legs dull testaceous, the apex of the antennæ somewhat infuscated. Membrane moderately infuscated, iridescent, the nervures green, vestiture of the upper surface minute and sparse, fuscous.

Say's material was from Indiana. I possess examples from Quebec, District of Columbia and California. This pale green little species may be distinguished from *flavosparsus* by the concolorous areoles and the want of intermixed pale hairs; from *fraternus* and *uniformis*, by the shorter elytra, and from *translucens*, by the dark vestiture and the genital characters of the male.

#### 8. *Orthotylus fraternus*, new species.

Very close to *translucens*, but with longer elytra clothed with fuscous instead of pale hairs. Length 4mm. to tip of the elytra.

Head substantially as in *translucens*, but with a transverse linear impression before the basal carina. Antennæ obviously more slender. Pronotum shorter than in the allied species, the sides feebly concavely arcuated with the angles more rounded. Elytra longer, the apex of the abdomen not surpassing the tip of the corium, the cuneus noticeably longer. The male genital characters are very close to those of *translucens*, but there are some differences. The dextral hook is more clavate at apex, the sinistral more curved and less inflated and the ventral aspect of the genital segment is shorter and less acutely produced.

The color of the present species is distinctly darker and more olive green, becoming yellowish toward the costa; the antennæ are darker throughout, the hairs on the upper surface are distinctly fuscous instead of pale, and the longer bristles of the tibiæ are blackish.

Described from five male examples taken at La Jolla, Calif., April 29, 1914; Alpine, San Diego County, Calif., June 5, 1913, and Pasadena, Calif., in May. This species I place next to *chlorionis* on account of its fuscous vestiture, but it is very close to *translucens*, although I believe it quite distinct. The genital characters are of little value here, but the darker color, longer elytra, fuscous vestiture, slender cuneus, more slender

and dusky antennæ and the linear impression on the base of the vertex will certainly distinguish it. I have one female taken at San Diego in April, 1913, that I believe belongs here. It has the elytra shorter, with the cuneus proportionately shortened and the sides of the pronotum almost rectilinear, but it has the same rounded pronotal angles, linear impression on the base of the vertex, dusky antennæ and fuscous vestiture.

Type, male, from Alpine, in author's collection. Paratypes in Museum of California Academy of Sciences (No. 307) and in author's collection.

### 9. *Orthotylus uniformis*, new species.

Aspect of the preceding, the head and beneath becoming more or less yellowish. Length  $5\frac{1}{2}$ -6mm. to the tip of the membrane.

Head more oblique than in the allied forms, leaving the apex more pointed when viewed from above. Eyes prominent, rounded, viewed from the side elongated and somewhat oblique. Vertex slightly flattened, the basal carina but feebly distinguished. Front but slightly convex; clypeus prominent; facial angle rather less than a right angle. Pronotum strongly narrowed before, rather flat, the callosities but little prominent, sides unusually oblique, slightly concavely arcuated; humeri prominent. Elytra long, the apex of the abdomen scarcely surpassing the base of the cuneus in the male, almost reaching to its tip in the female. Rostrum long, reaching on to the hind coxæ.

Dextral hook of the male genitalia short, straight, ligulate, its extreme apex incurved and subacute; sinistral hook long, curved in almost a semicircle, the apex slender and acuminate. Both hooks white in the dried specimens.

Color a uniform pale yellowish-green, becoming paler on the callosities, head, legs and lower surface; tip of the tarsi and of the rostrum black. Apical two joints of the antennæ infuscated. Upper surface sparingly clothed with short pale hairs. Membrane very faintly enfumed and highly iridescent, the nervures green.

Described from 15 examples representing both sexes, taken about Fallen Leaf Lake near Lake Tahoe, Calif., at an alti-

tude of 6,000 to 7,000 feet, during July, 1915. This is a tender pale green insect that must depend upon the characters of the male genitalia for final identification. I have also in my collection one pair from Salamanca, N. Y., and an example from Phoenix, Ariz., that have the same male genitalia and are otherwise inseparable from my Tahoe material.

Type, male, and allotype in collection of the University of California. Paratypes in Museum of California Academy of Sciences (Nos. 308, 309), collections of the University of California, and of the author.

#### 10. *Orthotylus translucens* Tucker.

Aspect of *uniformis*, but smaller with the head obviously shorter and more vertical and the first antennal joint shorter and thicker. Length 4mm. to the tip of the membrane.

Head small, short. Eyes unusually large and prominent; viewed from the side, ovate, reaching almost to the gula. Vertex flat with a large depressed area, the basal carina prominent but obtuse; front scarcely convex; clypeus small, the facial angle obtuse. Antennæ, first joint obviously shorter than the head when viewed from above; the second thick, scarcely thinner than the first and about four times longer. Pronotum short, one-half as long as its basal width, the anterior angles well rounded; callosities not prominent; basal lobe of the scutellum rather broadly exposed. Elytra long, the abdomen reaching to about the middle of the cuneus.

Male genitalia small, dextral hook short, a little widened toward its apex; sinistral also short and spatulate, but little longer than the dextral, its rounded apex fringed with short hairs. The large ventral aspect of the genital segment with a narrow subacute apex which rather surpasses the hooks.

Color clear green, becoming yellowish on the base of the scutellum, callosities, head and beneath. Apical two joints of the antennæ and tip of the second infuscated. Knees darker green in my examples; apex of the tarsi black. Elytral nervures darker green, most pronounced on the costal edge of the cuneus. Membrane very faintly infuscated, iridescent, the nervures pale green. Upper surface sparsely clothed with short pale hairs.

Redescribed from one pair taken on burdock growing on the bank on Niagara River at Buffalo, N. Y., June 28, 1908, and two males taken at Elma, N. Y., August 25, 1912.

I believe I have rightly identified Mr. Tucker's species as this, although certainty is impossible without reference to the type. I know, however, of no other species that answers so well to his description. The insects of this genus are without a pronotal collum and Mr. Tucker must have referred to the space anterior to the callosities as the collum.

### 11. *Orthotylus senectus*, new species.

Form of *coagulatus* but larger; whitish, irregularly dotted with green above. Length 4mm. to tip of membrane.

Head a little oblique, with the eyes two-thirds the width of the base of the pronotum. Vertex flat, twice as wide as the eyes; basal carina straight, prominent. Front strongly convex, almost overhanging the base of the clypeus. Clypeus very prominent, strongly arcuated before. Eyes prominent, viewed from the side reaching two-thirds the way to the gula. Antennæ rather short, the basal joint nearly as long as the head; third nearly or quite as long as the second. Rostrum almost attaining the apex of the hind coxæ, the first joint a little surpassing the base of the head. Pronotum formed as in *coagulatus*, the callosities prominent and the hind margin straight. Basal lobe of the scutellum but moderately exposed. Elytra as in the allied species, the costal margin gently bowing, widest opposite the tip of the clavus. Bristles of the hind tibiæ pale, shorter than the thickness of the joint.

Color whitish tinged with green on the pronotum and elytra and with fulvous on the head and legs; either side of the vertex with a faint fulvous cloud leaving the median line white. Posterior lobe of the pronotum and the elytra irregularly dotted with bluish green points. Membrane almost white, the nervures green. Upper surface sparsely clothed with short pale hairs.

Described from two female examples taken by me at Pueblo and Manitou, Colo., in July, 1900. This species is quite distinct by its whitish color dotted with green above. It doubtless lives on the whitish vegetation of the semi-arid districts

of Colorado. It is not impossible that the green elytral points may bear stiff dark hairs in fresh individuals.

Type, female, in collection of the author. Paratype, female, in Museum of California Academy of Sciences (No. 310).

## 12. *Orthotylus viridis*, new species.

Form of *dorsalis* but with the head and pronotum of *formosus*; pale green, with the head, anterior lobe of the pronotum and legs yellowish. Length 5mm.

Head as in *formosus*, a little oblique. Vertex slightly flattened, the basal carina straight and acute, not tumid and gently arcuated as in *formosus*. Front moderately convex. Clypeus small, prominent. Rostrum attaining the apex of the intermediate coxæ. Pronotum shaped as in *formosus*, with its sides feebly concavely arcuated and the humeri rounded; callosities large, but little prominent. Elytra nearly parallel, a little wider than in *uniformis*. Upper surface clothed with a minute pale pubescence.

Dextral hook of the male genitalia broad at base, tapering along its upper edge to an incurved subacute point, which nearly attains the opposite wall of the segment; sinistral slender, acute, surpassing the sinistral notch.

Color a nearly uniform green, usually quite strongly tinged with fulvous-yellow on the head, anterior lobe of the pronotum and scutellum, legs and venter, the costa often paler or whitish. Antennæ quite strongly infuscated, especially on the basal and apical joints. Apex of the tarsi blackish. Membrane whitish-hyaline, very slightly enfumed, the nervures pale green.

Described from two males and six females taken by Mr. H. H. Knight at Batavia, N. Y., July 5 and August 2, 1914, and one female taken by Mrs. Annie Trumbull Slosson at Lake Toxaway, N. C. This insect is most closely related to *formosus* and serves to connect that species with *dorsalis* and its allies on the one hand and *uniformis* and related forms on the other.

Type, male, and allotype in collection of H. H. Knight. Paratypes in collections of H. H. Knight, Mrs. A. T. Slosson, Museum of California Academy of Sciences (No. 311), and collection of the author.

13. *Orthotylus nigrinasi*, new species.

Size and form, about, of *viridicatus*, the head a little larger and the eyes larger and more prominent; color pale green, the green on the elytra segregated, leaving clear places; first antennal joint biannulate with black, the apex of the head conspicuously black. Length 4mm. to tip of the membrane.

Head large, two-thirds as wide as the hind margin of the pronotum. Eyes unusually prominent; viewed from the side, but little longer than broad. Vertex flattened, leaving the hind margin distinctly carinate almost to the eyes. Front prominent, strongly convex; clypeal sutures deep. Basal antennal joint about as long as the head, the second scarcely three times longer. Pronotum almost flat, the callosities scarcely prominent; anterior margin straight, sides feebly concave, the anterior angles but little rounded; humeri prominent. Elytra flat, the tip of the cuneus scarcely surpassing the apex of the abdomen.

Color above green, the pronotum before, head and all beneath, pale or yellowish, more or less tinged with green; the green of the upper surface being gathered into irregular patches, especially on the elytra, leaving pale areas more numerous toward the costa. Base of the vertex with a short brown longitudinal median line; neck with a square black spot behind each eye, which is scarcely noticed unless the head is exerted. Apex of the head deep black, polished, the bounding line passing across the apex of the front just above the base of the clypeus and obliquely down each side a little below the lower angle of the eyes. Antennæ pale (apical joints wanting); the first joint black at base with a broad black annulus just before the apex; second narrowly black at base and dusky toward the apex. Membrane but slightly enfumed, with a darker cloud beyond the tip of the areoles; nervures green. Vestiture wanting from the type, but apparently pale. Legs pale, apical half of the tarsi, extreme tip of the tibiæ and apex of the rostrum black.

Described from one female taken by Mr. F. Payne at El Paso, Texas, August 31, 1911. The annulated first antennal joint and the remarkably black "nose" will at once distinguish this very distinct species.

Type, female, in author's collection.

GROUP II (Subgenus *Orthotylus* ?)14. *Orthotylus ovatus*, new species.

Form nearly of *Lygus apicalis*. Ovate, broader than the typical forms of this genus; green, nearly uniform, clothed with sparse black deciduous hairs and minute white pubescence; membrane infuscated. Length  $4\frac{1}{2}$  mm. to tip of membrane.

Head broad, convex; vertex flattened, transversely depressed before the prominent basal carina. Front unusually convex, polished; clypeus small and but little prominent. Eyes large, about one-half the width of the vertex; viewed from the side ovate, a little oblique, reaching below the middle of the sides of the head. Antennæ normal, the first joint shorter than the head. Pronotum transverse, more convex than usual in this genus; anterior angles well rounded; callosities large, moderately elevated. Elytra short and broad, the costa regularly but not greatly arcuated, the apex of the abdomen passing the middle of the cuneus in the male, attaining its apex in the female. Rostrum long, reaching about to the base of the venter.

Dextral hook of the male genitalia long, widened to the truncated apex, long triangular, with a very sharp spur at the superior apical angle, this spur but little shorter than the width of the piece at that place; sinistral hook broad, ligulate, its rounded apex attaining the sinistral margin.

Color pale green, becoming more or less yellowish. Upper surface clothed with short black hairs and a minute white pubescence, easily denuded. Antennæ a little infuscated. Membrane quite strongly infuscated, usually pale at base, the nervures pale. Tibial bristles pale. Tip of the last tarsal joint black. In faded specimens the thickened costal nervure is the last to lose its green color.

Described from numerous individuals beaten from juniper trees along Glen Alpine Creek near Fallen Leaf Lake, Calif., during July.

This species is very close to *Oncotylus puberus* Uhler, but after a careful examination of the types I am unable to consider them the same.

Type, male, and allotype in collection of University of California. Paratypes in Museum of California Academy of Sciences (No. 312), collection of the University of California and author's collection.

15. *Orthotylus catulus*, new species.

Form of *ovatus*, but a little broader; aspect somewhat of *Oncotylus punctipes* Reut.; uniformly pale testaceous-gray or a little brownish. Length  $4\frac{1}{2}$  mm. to tip of membrane.

Head more triangular before and less convex than in *ovatus*. Vertex flattened, forming a large depressed area, rounded before; basal carina very obtuse; front but moderately convex. Clypeus large and prominent, its basal suture somewhat above the line of the antennæ. Antennæ rather short; basal joint obviously shorter than the head when viewed from above, exceeding the clypeus by less than one-third its length; second little thinner than the first. Pronotum less convex than in *ovatus*, but more so than in the *flavosparsus* and *dorsalis* groups; sides straight; anterior angles scarcely rounded; anterior margin distinctly concavely arcuated; callosities large, not prominent. Elytra broad, the costa rather strongly arcuated; apex of the abdomen reaching the base of the cuneus in the male, rather surpassing its apex in the female. Rostrum long, about attaining the base of the abdomen.

Male genital pieces very small; dextral hook short, ovate, scarcely longer than broad; sinistral broad, irregularly triangular, filling the sinistral notch, its broad apex oblique with the angle rounded.

Color a nearly uniform pale testaceous, having a whitish aspect in life; the elytra more or less infuscated, the membrane sometimes a little more deeply infuscated with the nervures pale. Pectoral pieces tinged with fulvous. Tips of the tarsi and rostrum black. Upper surface clothed with short fuscous hairs, which are but little darker than the surface of the insect. Antennæ scarcely darker at apex.

Described from numerous examples taken on *Gnaphalium uliginosum* at Hamburg, N. Y., June 6, 1909, and at Niagara Falls, June 13. The pale testaceous color of this insect gives it the appearance of being immature.

Type, male, and allotype in author's collection. Paratypes in Museum of California Academy of Sciences (Nos. 313-315), collection of the University of California and author's collection.

GROUP III (Subgenus *Diommatulus* Uhler).

16. *Orthotylus languidus*, new species.

Larger than *dorsalis*, elongated, with somewhat the aspect of a *Plagiognathus*; a pale immature looking insect with faint fuscous markings in the male. Length  $5\frac{1}{2}$  mm. to tip of membrane.

Vertex flattened, the basal carina prominent, the impression before it forming two fovæ as in most of the *dorsalis* group. Front convex, especially in the female. Eyes large; in the male two-thirds the width of the vertex, in the female about one-half. Antennæ rather short. Pronotum long, its length two-thirds its basal width; sides very feebly concave, the anterior angles well rounded; callosities large, prominent. Elytra nearly parallel, the costa a little arcuated; almost subhyaline in texture; apex of the abdomen in the male reaching the middle of the cuneus, in the female attaining its apex.

Dextral hook of the male genitalia large, very broad and convex at base, the apex rather abruptly narrowed and incurved with its apex rounded; sinistral small, linear, lying along the lower margin of the very deep sinistral notch.

Color pale whitish-testaceous, with the elytra almost diaphanous and the typical markings much reduced. Upper surface clothed with rather long and dense pale hair. In the female the colors are almost uniform over the whole surface, with only the extreme tips of the tarsi infuscated. The male is quite distinctly clouded with brown or fuscous on the disk of the vertex and on the pronotum behind the callosities, and there is a faint cloud at the apex of the clavus and two elongated ones before the apex of the corium; the membrane also has an elongated fuscous mark beyond the apex of the areoles. Sides of the basal lobe of the scutellum black. Abdomen and sternum more or less infuscated with the connexivum paler.

Described from numerous examples taken on willows at Mussey's and at Grossmont in San Diego County, Calif., in

April and May. This species has a peculiar washed-out immature look, which, with its slightly larger size, will distinguish it from our other willow species.

Type, male, and allotype in author's collection. Paratypes in Museum of California Academy of Sciences (No. 316), collection of the University of California and in author's collection.

#### 17. *Orthotylus formosus*, new species.

Elongate-ovate, pale green or yellowish, polished, the typical markings reduced; hind margin of the pronotum slenderly black and there is a black mark behind the callosities. Length 7mm. to tip of the membrane.

Head somewhat oblique, not so nearly vertical as in our other species. Vertex scarcely flattened, the basal carina prominent; front broad, convex, polished; clypeus narrow, prominent and strongly arcuated. Eyes not very prominent; viewed from the side, oval, oblique, reaching below the middle of the side of the head. Antennæ long, the basal joint longer than the head, surpassing the clypeus by at least three-fourths its length; second about three and a half times the length of the first. Pronotum long, much narrowed anteriorly, its length two-thirds its basal width. Callosities large, oval, the disk behind them rather strongly convex and polished. Scutellum large, its basal lobe well exposed. Elytra long with the costal margin gently arched; apex of the abdomen reaching to about the tip of the cuneus. Rostrum attaining the apex of the intermediate coxæ. Oviduct of the female long, beginning before the middle of the venter.

Color a clear pale greenish, becoming yellowish on the scutellum, pronotum, legs and lower surface; basal lobe of the scutellum and head fulvous. Antennæ and tarsi black, the basal joint of the former dusky green. Hind edge of the pronotum and an arc behind the callosities which may be extended in a sinuate transverse line, black. Vertex with two subbasal dashes and two minute approximate points before them brown; the base of the clypeus with a small fuscous spot. Elytra marked with a slender black line next the scutellum and a shorter one on the apical margin at base of the membrane; middle line of the clavus with a long fuscous ray and near the

inner angle of the corium is an oblong fuscous spot. Membrane more or less infuscated, with a pale median vitta, the nervures green. Abdomen more or less greenish with the stomata darker and the tip of the oviduct black. Upper surface sparsely clothed with pale hairs.

Described from two female examples taken from alder bushes on the south slope of Mt. Tallac above Glen Alpine Springs, near Lake Tahoe, Calif., July 30, 1915. I tried in vain to find this species on the alders growing along Glen Alpine Creek two or three hundred feet lower. It is probable that the species was not then fully in season.

Type, female, in collection of University of California. Paratype, female, in Museum of California Academy of Sciences (No. 317).

#### 18. *Orthotylus modestus*, new species.

A little broader than *dorsalis*; pale gray, the dark markings much reduced, those on the pronotum forming two transverse vittæ. Length 5mm. to tip of membrane.

Head about as in *dorsalis*. Vertex narrowly flattened before the basal carina. Front a little more convex and less polished than in *dorsalis*. Pronotum more convex and a little broader anteriorly, the sides nearly rectilinear; anterior angles well rounded; surface transversely rugose; callosities scarcely prominent, ill-defined. Basal lobe of the scutellum a little exposed. Elytra rather short, the abdomen surpassing the tip of the cuneus; costal margin regularly slightly arcuated, rather more so than in *dorsalis*. Tibial spines longer and stouter than in the allied species, distinctly longer than the thickness of the segment.

Color, female, pale greenish shading to yellowish in places, deeper green along the claval suture. Upper surface distinctly gray-pubescent. Head pale tinged with fulvous, with a brown dot on the base of the clypeus. Antennæ pale, a little infuscated. Pronotum pale with a fuscous arc behind each callosity. These arcs may unite and form a transverse vitta, not attaining the margin. Hind margin with a broader fuscous vitta, which omits the humeral angles. Basal area of the scutellum more or less fulvous. Elytra pale or somewhat greenish; the

clavus, except at base and apex, fuscous; corium with a large fuscous cloud on the inner angle, which, at the middle, has an extension toward the costa; cuneus pale. Membrane well infuscated, the nervures pale except at their base. Beneath and legs pale, more or less tinged with green, the apex of the tarsi black.

Male much darker; head above, basal joint of the antennæ, pronotum, clavus, membrane and most of the lower surface black; the black color on the corium more extended and occupying fully one-half the surface; first antennal joint black; second, brown, yellowish at base; third and fourth, fuscous.

Dextral hook of the male genitalia black, broad and strap-like, transverse, a little widened at base, its blunt apex incurved, almost reaching the sinistral wall; sinistral hook straight, apparently terete, not thicker than the second antennal joint, surpassing the apex of the ventral surface of the genital segment.

Described from five males and eight females. Of these I took two females at Salamanca, N. Y., July 20, 1911, and one at Buffalo, N. Y., August 4, 1901. Mrs. Annie Trumbull Slosson has sent me three females taken at Delaware Water Gap, Pa., and from Mr. H. H. Knight I have received three males and two females taken at Honeoye Falls, N. Y., July 1, 1915, and two males taken at Batavia, N. Y., July 10, 1914.

Type, female, in collection of author. Allotype, male, in collection of H. H. Knight. Paratypes in collections of H. H. Knight, Mrs. A. T. Slosson, Museum of California Academy of Sciences (No. 318) and in author's collection.

#### 19. *Orthotylus dorsalis* Provancher.

Elongated with the elytra nearly parallel; black; head, at least the occiput, sides and median vitta, usually, of the pronotum, broad costal margin, lower surface excepting a broad lateral vitta, legs and the antennæ of the female, pale or greenish. Length 5-5½mm. to tip of membrane.

Head almost vertical. Eyes prominent, especially in the male; viewed from the side oval, little longer than broad; reaching below the middle of the head. Vertex narrowly flattened and a little excavated before the basal carina; in the male but little broader than the eye, about twice as broad in the fe-

male. Front moderately convex, polished; clypeus small, but little prominent. Antennæ rather short, the basal joint as long as the head; second about three and one-half times as long as the first. Pronotum rather long and much narrowed before, its length two-thirds its basal width, the sides distinctly concavely arcuated with the anterior angles well rounded; surface rather flat, obscurely transversely rugose; callosities large, oval, moderately prominent, distinctly separated by a depressed area. Basal lobe of the scutellum well exposed. Elytra nearly parallel, the costa feebly arcuated; tip of the abdomen nearly attaining the apex of the cuneus in the male, quite so in the female.

Male genital hooks black; the dextral large, slender at base and expanded to an oblique triangular apex which passes the middle of the anal opening; sinistral hook finger-like, considerably surpassing the apex of the segment, clothed with minute hairs.

Color above black; beneath pale with a blackish vitta along each side, which in the male may be so extended as to cover nearly the entire lower surface. Pronotum pale with two approximate black dorsal vittæ which in the male are so extended as to cover nearly or quite the entire surface. Head in the male black, polished, with the occipital margins, antennal sockets, lower cheeks and tip of the clypeus pale; in the female pale with a large brown annulus on the front and sometimes with two small points above it and a large black spot between the antennæ covering the disk of the clypeus, apex of the front and inner cheeks. Antennæ black in the male, pale and somewhat infuscated in the female. Scutellum black, with a pale median vitta in the female and sometimes in the male. Pale costal border of the elytra encroaching upon the black disk along the claval suture and principal nervure, especially in the female; cuneus pale with the apex a little infuscated at times. Membrane infuscated, the nervures pale and with a pale spot at their apex in the female. Legs pale, the weak tibial bristles also pale, the apex of the tarsi black. Upper surface sparsely clothed with minute pale hairs.

Redescribed from a good series taken at Quinze Lake, P. Q., and about Buffalo, N. Y. It occurs on willows. I would not be surprised to learn that the females of this species are

dimorphic, some of them being like the males in color. I have carefully studied the types of both Provancher's and Uhler's species (*congrex*) and they seem to be absolutely identical.

## 20. *Orthotylus marginatus* Uhler.

Closely allied to *dorsalis*, but with the females colored dark like the males and with different male genital characters. Length  $5\frac{1}{2}$  mm. to tip of membrane.

Vertex but little flattened, with a slight depression before the feeble basal carina; front but slightly convex, polished; clypeus small and less prominent than in most of our species. Eyes unusually large; viewed from the side broadly ovate, reaching nearly to the gula, very little smaller in the female than in the male. Pronotum almost smooth, the sides distinctly concave, the anterior angles well rounded; callosities prominent, usually connected anteriorly by a slight ridge. Basal lobe of the scutellum well exposed. Elytra long, nearly parallel, the costal margin but feebly arcuated; apex of the abdomen reaching the middle of the cuneus in the male and nearly to its tip in the female. Upper surface rather sparsely clothed with pale appressed hairs. Rostrum long, reaching well on to the hind coxæ.

Dextral hook of the male genitalia large, pale, reaching nearly across the anal opening, its apex obliquely rounded and armed with a few comb-teeth, near the base produced dorsally and backward in a sinuated acute projection which is about one-half as long as the lower member; sinistral hook long, flattened and expanded at the rounded apex, produced for one-half its length beyond the ventral apex of the genital segment.

Color as in the male of *dorsalis*, black; occiput, lower cheeks, gula, base of the vertex, median vitta of the pronotum, at times continued over the scutellum, and the sternum, pale or tinged with fulvous; costal margin of the elytra, middle of the venter and the legs pale greenish-yellow. Pale color of the costa sometimes encroaching upon the base of the clavus along its suture and on the principal nervure of the corium in the female, rarely in the male; inner angle of the cuneus usually infuscated. Membrane blackish with the nervures pale at apex.

Redescribed from a good series taken, with *dorsalis*, on willows and thorn bushes, there probably accidental. The males of this species and of *dorsalis* are nearly indistinguishable except in their genital characters, but in *dorsalis* they more often have the pronotum and scutellum entirely black.

21. *Orthotylus molliculus*, new species.

Allied to *dorsalis* with the dark markings much reduced, the face with a black X-shaped mark. Length 5mm. to tip of membrane.

Head broader than in the allied species. Vertex flattened, with a distinctly foveate impression before the prominent basal carina. Front but slightly convex; clypeus small. Eyes large, nearly two-thirds the width of the vertex; viewed from the side short, ovate, reaching nearly to the gula. Antennæ short; third and fourth joints together not three-fourths the length of the second, the fourth about equal to the first and two-thirds the length of the third, a little dilated and flattened at apex. Pronotum shorter than in *dorsalis*, more convex, the sides feebly concave, the anterior angles rounded; callosities large, closely approximated, moderately elevated. Basal lobe of the scutellum but little exposed. Elytra rather short, about as in female *dorsalis*, the apex of the abdomen hardly reaching to the middle of the cuneus.

Male genitalia whitish; dextral hook rather large, a little curved inward and upward, the apex truncate and drawn out dorsally into about four sharp teeth, near the base with an oblong plate projecting dorsally, the inner angle of which is produced in an acute tooth; sinistral hook long and spatulate, much exceeding the ventral aspect of the segment.

Color whitish-testaceous, perhaps tinged with green in life, with a slight tint of yellow on the head and scutellum; the basal lobe of the scutellum marked with black and fulvous. Face marked with a large black X from the antennæ to the basal fovæ, the pale angle above the clypeus sometimes filled in with black; clypeus and outer cheeks in part black. Antennæ black. Callosities black, connecting with a large fuscous spot on either side of the disk of the pronotum. Sides and suture of the scutellum black. Elytra pale with a fuscous cloud

covering the disk of the clavus, another on the corium within, exterior to which is a short fuscous ray; cuneus entirely pale. Membrane blackish-fuscous, the nervures pale at apex. Extreme base of the elytra touched with fuscous. Pleural pieces mostly black. Abdomen black with the disk and margins pale. Legs very pale green, the tarsi infuscated and black at apex. Upper surface clothed with short pale pubescence.

Described from two male examples taken on willows at Mussey's and near Grossmont, San Diego County, Calif., in April and May, 1913.

Type, male, in author's collection. Paratype, male, in Museum of California Academy of Sciences (No. 319).

## 22. *Orthotylus affinis*, new species.

Very near *molliculus*, a little larger and darker with the basal joint of the antennæ pale, the pronotum narrower before, the pale costal border broader and not marked with a fuscous ray, the sides of the body beneath scarcely marked with black, and a different male genitalia. Length 6mm. to tip of membrane.

Head as in *molliculus*, the vertex strongly impressed before the prominent basal carina, the clypeus but moderately prominent. Eyes oval, viewed from the side proportionately narrower than in the allied species. Pronotum apparently longer, the pale space before the callosities broader and the anterior angles much rounded, making the anterior margin look shorter. Legs longer, the hind femora distinctly surpassing the tip of the abdomen.

Male genitalia larger, pale; the dextral hook produced into a long sickle-shaped piece, acute at apex and serrated for a space along the external edge, the base angled but without a square projection, the curve forming a little more than a half circle; sinistral hook longer, a little curved and distinctly expanded toward the apex.

Color a very pale testaceous or greenish. Vertex with a pair of subtriangular black marks in the foveate basal impressions. Front with a blackish arc on either side, united above where they nearly or quite connect with the basal marks; on the base of the clypeus is a black polished spot which encroaches

upon the outer cheeks. Antennæ dark greenish-piceous, the basal joint more green. Sides of the pectus and abdomen with a narrow blackish vitta which is wanting in the female. Pronotum marked with a broad black vitta on either side, usually connected with the black callosities. Scutellum black, the anterior lobe sometimes marked with fuscous, the posterior with a linear median pale vitta. Elytra blackish-fuscous, the broad costa and a slender line along the commissure and suture of the clavus pale, the cuneus entirely pale. Membrane deeply infuscated, the nervure pale except at base. Legs greenish, the tibiæ more dusky, the apex of the tarsi black.

Described from numerous examples taken from willows about Fallen Leaf Lake, near Lake Tahoe, Calif., in July, 1915. Best distinguished from *molliculus* by the narrower and more rounded anterior margin of the pronotum, the linear pale vitta on the scutellum, the narrower blackish lateral vitta beneath, the want of a fuscous ray in the pale costal area, and the dark olive-green antennæ which become blackish at times. Male genital hooks much more developed and very characteristic.

Type, male, and allotype in collection of University of California. Paratypes in Museum of California Academy of Sciences (Nos. 320, 321), collection of the University of California and in author's collection.

### 23. *Orthotylus angulatus* Uhler.

Smaller and more slender than *dorsalis*; dark fuscous-brown, base of the pronotum sometimes paler, the base of the corium and the cuneus whitish. Length 4mm. to tip of membrane.

Head short. Vertex short, with an impressed line before the obtuse basal carina; in the female this line connects with two fovæ which are nearly obsolete in the male. Clypeus large, prominent. Eyes large, about two-thirds as wide as the vertex; viewed from the side oval, nearly reaching the line of the gula. Antennæ stout and rather long, the basal joint longer than the head viewed from above; third and fourth slender, together about as long as the second. Pronotum rather short, the sides nearly rectilinear, the anterior angles rounded; callosities large, approximate, little elevated. Anterior lobe of the scutellum

covered or nearly so. Elytra parallel, narrow, apex of the abdomen but little surpassing the base of the cuneus in the male, hardly attaining its apex in the female. Rostrum and hind tibiae unusually long, the former attaining the base of the hind coxae.

Redescribed from two females, one taken by me at Denver, Colo., July 12, 1900, the other, also from Colorado, was sent to me by Prof. Carl F. Baker with the label *Diommatus angulatus* Uhler; they, however, differ from Uhler's description in several points. The clypeus is paler in one of my specimens and not darker in the other, the hind lobe of the pronotum is distinctly paler and the clavus is deep fuscous and not pale yellowish as described by Uhler. There is, however, just such a pale area on the base of the corium adjoining the claval suture. The apex of the cuneus is also but little darkened. These discrepancies can all be accounted for by the ordinary variations found in this genus except the pale clavus, a character found in no species of this genus known to me. It is not unlikely that Dr. Uhler thoughtlessly mistook the cuneate pale mark on the base of the corium for a pale clavus. Unfortunately I have no males of this form.

An examination of one of Uhler's types, kindly sent to me for study by Prof. Gillette, confirms in every respect my determination as given above.

#### 24. *Orthotylus angulatus brunneus*, new subspecies.

This form is very close to that described above as *angulatus* except that the pale mark on the base of the corium is reduced to a line along the claval suture, and the costal margin is narrowly pale.

Male genitalia small; dextral hook ovate at apex; the sinistral lying along the margin of the sinistral notch, its apex curved upward and acute.

Founded on numerous examples taken on willows at many localities in San Diego County, Calif., from April to June. It is possible that an examination of the male genitalia of *angulatus* will show this to be a distinct species, but that is not likely to be the case.

Type, male, and allotype in author's collection. Paratypes in Museum of California Academy of Sciences (Nos. 322, 323), collection of the University of California and in author's collection.

25. *Orthotylus cuneatus*, new species.

Very near *angulatus brunneus*, but larger with longer elytra and darker colors; marked as in *angulatus* with a pale wedge-shaped area along the claval margin of the corium. Length 5mm.

Head as in *brunneus*, the vertex with a deep foveate impression before the prominent basal carina. Front feebly convex. Clypeus small, prominent. Antennæ long; basal joint rather longer than the head; second longer than the third and fourth together. Pronotum short, the sides very oblique, sinuated; humeri subacute, prominent; the anterior angles rounded; callosities large, prominent. Elytra long, parallel.

Male genitalia small; dextral hook small, longer than broad; sinistral a little longer, lying in the sinistral notch, its hind edge rounded.

Color sooty-black, a little piceous in immature examples, the antennæ piceous. Legs dark chestnut, the anterior paler or brownish-testaceous in some individuals; coxæ and base of the femora pale testaceous. Elytra with a large wedge-shaped whitish mark lying against the claval suture; apex of the corium and base of the cuneus covered by a rather large whitish spot. Membrane nearly black, a little clearer toward the apex, the nervures black.

Described from two males and five females taken by me about the lower end of Fallen Leaf Lake, Calif., in July, 1915. Structurally this species is very near *brunneus*, but its larger size and stronger coloring, together with the cuneate mark on the base of the corium, will readily distinguish it.

Type, male, and allotype in collection of University of California. Paratypes in Museum of California Academy of Sciences (No. 324), collection of University of California and in author's collection.

26. *Orthotylus pullatus*, new species.

Closely allied to *brunneus*; blackish, the costal margin narrowly pale; male genital segment long and unusually slender. Length  $4\frac{1}{2}$  mm. to tip of membrane.

Basal impression of the vertex large, including two conspicuous pits, the basal carina prominent; front but moderately convex. Eyes, viewed from the side, ovate, reaching nearly to the gula. Pronotum proportionately shorter than in *brunneus*, the sides distinctly arcuated with the humeral angles subacute and upturned; callosities large and prominent. Elytra a little more widened toward the apex of the corium than in the allied species. Antennæ a little thinner than in *brunneus*, the third and fourth joints together scarcely as long as the second.

Genital segment of the male in *brunneus* triangular, hardly longer than broad at base; in *pullatus* nearly cylindrical, about twice as long as wide at base, the apex elliptically rounded. Genital hooks small and black; the dextral elongate ovate, curved inward and backward at apex; the sinistral elongated, lying along the sinistral notch, its apex rounded.

Color blackish-fuscous. Head black, apex of the clypeus sometimes touched with castaneous. Antennæ black. Pronotum at times showing a mere tinge of castaneous behind the callosities. Coxæ at base and the middle of the sternum and venter pale. Elytra a shade paler than the body, the costal margin narrowly pale and extended nearly to the apex of the cuneus. Membrane nearly black, the nervures concolorous or barely touched with pale at apex. Legs dark castaneous. Upper surface clothed with pale pubescence.

Described from one male and eight female examples taken by me May 13, 1915, on willows growing among the sand dunes at San Francisco, Calif. This species is best distinguished from the closely allied *brunneus* by the darker color, the prominent, subacute, humeral angles, and the long, narrow male genital segment.

Type, male, and allotype in collection of University of California. Paratypes in Museum of California Academy of Sciences (No. 325), collection of University of California and in author's collection.

27. *Orthotylus cruciatus*, new species.

Allied to *lateralis* but much larger with a black scutellum. Aspect somewhat of *Plagiognathus obscurus* Uhl., but larger and more clearly marked. Length  $5\frac{1}{2}$ -6mm. to tip of membrane.

Head small, polished. Vertex slightly depressed, the basal carina slender and inconspicuous; front convex, highly polished; clypeus small, prominent. Eyes very large, much wider than the vertex; viewed from the side ovate, reaching about to the gula; the apex of the head projecting more than in *lateralis*. Antennæ long, the first joint longer than the head; second scarcely thinner, fully four times the length of the first; apical two together about equal to the second. Pronotum long, nearly flat, the sides feebly concave, the anterior angles subacute; callosities large, little elevated, extending much farther back than in *lateralis*; basal margin feebly concave, leaving the base of the scutellum less exposed. Elytra long, parallel, the apex of the abdomen just passing the base of the cuneus in the male, reaching nearly to its middle in the female; cuneus narrow and acute, its length fully twice its basal width.

Male genitalia pale testaceous; dextral hook long-triangular, its lower angle subacute, the upper rounded; sinistral ligulate and incurved.

Color black and nearly white. Head black, polished; a dot against the inner angle of each eye and sometimes a basal spot pale testaceous or fulvous. Antennæ black. Pronotum with the callosities and broad lateral margins black, the disk pale. Scutellum black, the basal lobe marked with fulvous. Elytra whitish, the clavus and a broad transverse band across the apex of the corium black; cuneus with a fuscous spot before its apex. Upper surface sparsely clothed with short, pale hairs. Beneath pale with a broad black vitta along either side and covering the genital segment. Legs pale yellowish-brown, becoming lighter at base, the tips of the tarsi black.

Described from seven examples, two males and one female, taken by me at Portland, Maine, July 9, 1910; a female taken by Mr. Metcalfe at St. Hilaire, P. Q., July 4, 1907; one male taken by Mr. C. A. Frost at Sherborn, Mass., June 24, 1914, a female taken at Marshfield, Mass., in August, from the

collection of the Boston Society of Natural History, the last two kindly sent me for study by Mr. H. C. Parshley, and a male taken at Stowe, Vt., July 4, by G. P. Engelhardt. This is a large, clearly marked species and may be known by the black lateral margins of the pronotum and conspicuous cruciate black markings on the elytra.

Type, male, and allotype in author's collection. Paratypes in Museum of California Academy of Sciences (No. 326), collections of the Boston Society of Natural History of Mr. H. C. Parshley, and in the collection of the author.

#### 28. *Orthotylus lateralis*, new species.

A little larger and broader than *brunneus*; pronotum pale with the lateral margins broadly black. Length  $4\frac{1}{2}$  mm. to the tip of the membrane.

Head more oblique than in *dorsalis* and its allies. Vertex flat, the foveate depression rather obscure and the basal carina feeble. Front convex, polished, the clypeus small and prominent. Eyes very large, in the female as wide as the vertex, wider in the male; when viewed from the side, ovate, reaching to the gula and but little surpassed by the apex of the head. Pronotum long and much narrowed anteriorly, the sides very slightly arcuated, the anterior angles subacute; callosities very small and placed close to the anterior margin, leaving the impressed bounding line behind them at about the anterior one-third of the pronotum; hind margin a little concave, leaving the basal lobe of the scutellum broadly exposed. Elytra broader than in *brunneus*, about as in *modestus*, nearly parallel, the apex of the abdomen reaching the middle of the cuneus in the male and its apex in the female.

Male genitalia prominent; dextral hook long, pennate, the ventral edge smooth, the dorsal "feathered" or flattened and serrated on the apical half, tapering to an acute point; sinistral long, nearly straight, toward its apex triangularly widened and armed within with a stout tooth.

Color fuscous-brown; head at base and below becoming pale yellowish. Antennæ black. Pronotum pale yellowish, the sides broadly black both above and below. Basal lobe of the scutellum fulvous, apical pale yellowish. Clavus blackish-

fuscous, the commissure and apex whitish; corium fuscous, the claval suture, slender costal nervure and a ray along the principal nervure, whitish; cuneus fuscous with the basal half almost white. Membrane lightly infuscated, with a darker ray beyond the angle, the nervures fuscous. Sides of the pleural pieces and venter fuscous, the middle line broadly whitish. Legs tinged with yellow, deeper toward the apex of the hind femora; tip of the tarsi black. Upper surface sparsely clothed with pale hairs. In the female the pale colors are much extended.

Described from two males and two females taken by me at Effingham, Kansas, Pueblo and Denver, Colo., all in July, 1900. This species is readily recognized by the yellowish tinge to the vertex and pronotum with conspicuous black lateral margins to the latter and the fulvous base of the scutellum.

Type, male, and allotype in author's collection. Paratypes in collection of the author and in Museum of California Academy of Sciences (No. 327).

#### 29. *Orthotylus knighti*, new species.

Allied to *lateralis*, but longer winged and darker colored, the elytra black with a subcostal pale vitta, which in the female reaches and largely covers the cuneus. Length 5mm. to tip of membrane.

Head short as in *lateralis*. Vertex much depressed and sunken below the level of the eyes; basal impression triangular with the fovæ discernable, the basal carina slender but distinct. Front but little convex, polished; clypeus small, strongly arched before. Eyes very large and prominent; in the male as wide as the vertex, about one-half narrower in the female; viewed from the side, broad ovate, reaching nearly to the gula. Pronotum much narrowed anteriorly; sides distinctly arcuated, the humeri prominent and the anterior angles subacute; callosities prominent, oblique. Elytra long, parallel, the costa straight; cuneus slender. Basal lobe of the scutellum well exposed. Antennæ as in *lateralis*, the basal joint perhaps a little longer.

Dextral hook of the male genitalia black, subtriangular, transverse, its lower edge straight, the upper oblique with the

obtuse apex incurved; sinistral finger-like or a little thickened toward its apex, a little shorter than the dextral.

Color black, polished on the front and clypeus; vertex, occipital margins and antennal sockets obscurely fulvous. Disk of the posterior lobe of the pronotum in the female broadly dull fulvous, the callosities tinged with the same color. In the male this fulvous disk is much reduced. Coxæ and legs pale fulvous, the apex of the femora and tibiæ becoming infuscated, in the male almost black, the tip of the tarsi black. Disk of the corium in the female with a whitish vitta, broadest near the base and expanded on the cuneus so as to cover all but the inner angle and apical margin. In the male this pale ray is much reduced and confined to the base of the corium. Membrane black with a pale line along the apical margin of the cuneus, which sometimes encroaches upon the apex of the nervures.

Described from one male and three female examples taken on willow at Batavia, N. Y., July 5, 1914, by Mr. H. H. Knight, who has kindly sent them to me for study and to whom it gives me pleasure to dedicate this interesting species.

Type, male, and allotype in collection of H. H. Knight. Paratype in author's collection.

### 30. *Orthotylus ornatus*, new species.

Size of *formosus*, but proportionately broader. Pale greenish varied with fuscous and sometimes tinged with sanguinous; median line of the pronotum and apical field of the scutellum in the female pale. Length 6mm. to tip of the membrane.

Head vertical. Vertex flat, but little depressed; the fovæ obscure, basal carina distinct. Front scarcely convex; clypeus narrow, moderately prominent. Eyes large, about two-thirds the width of the vertex; viewed from the side broad ovate, but little narrowed below, reaching nearly to the gula. Pronotum broad, rather flat; sides a little concavely arcuated, the humeri prominent; anterior angles but little rounded; surface opaque and distinctly shagreened; callosities little elevated. Antennæ short; first joint as long as the head; second nearly as long as the head and pronotum together; third and fourth conjointly about two-thirds the length of the second. Basal lobe of the scutellum somewhat exposed. Elytra broad, the costa a little

bowing; cuneus long and narrow, scarcely attaining the tip of the abdomen in the female, surpassing it in the male. Rostrum short, reaching on to the intermediate coxæ.

Dextral hook of the male genitalia broad on its basal half, the ventral margin abruptly produced and incurved at the apex which nearly attains the sinistral margin of the segment; sinistral hook slender and incurved.

Color pale green; sides of the venter and pectus more or less infuscated or black, almost entirely fuscous in the male. Head greenish or reddish-brown; the basal fovæ and two approximate spots on the base of the front fuscous, the latter sometimes forming vittæ; clypeus pale anteriorly. Pronotum dark reddish fuscous, becoming black laterally and behind the callosities or entirely black in the male; median line sometimes enlarged so as to cover the disk posteriorly; lateral edges and the surface anterior to the callosities pale or whitish in the female. Scutellum black, the basal lobe sometimes with a red spot on either side, the disk of the apical lobe pale. Elytra pale or tinged with reddish, the clavus infuscated, at least apically; apical half of the corium irregularly fuscous, omitting the slender costal and apical margins; cuneus whitish, fuscous at apex in the male. Membrane infuscated, the disk of the areoles nearly black, with a darker ray beyond them. Antennæ rufo-testaceous, infuscated at apex, the basal joint brown or black. Legs pale; hind femora infuscated on the apical two-thirds; tips of the tarsi black.

Described from three females and one male taken at Honey Falls, New York, in June and July, 1915, by Mr. M. D. Leonard and kindly sent to me for study by Mr. H. H. Knight. The large size and maculated membrane will distinguish this species. It has somewhat the aspect of *Lopidea cuneata* Van D. or of a *Plagiognathus*, but the free connivent arolia and other characters show it to be a true *Orthotylus*.

Type, male, and allotype in collection of H. H. Knight. Paratypes in collections of H. H. Knight and the author.

### 31. *Orthotylus submarginatus* Say.

Allied to *lateralis*, but rather more slender. Color above, pale salmon yellow, median vitta and slender costal line on the

elytra and the pronotal margins black. Length 4mm. to tip of the membrane.

Head vertical; base of the vertex depressed, the basal carina prominent. Pronotum a little narrower than in *lateralis*, the humeral angles more prominent; surface sloping, scarcely convex, nearly smooth. Basal lobe of the scutellum well exposed. Elytra nearly parallel; the apex of the abdomen nearly attaining the tip of the cuneus.

Color light salmon-yellow. Tip of the head with a polished black spot covering the apex of the front, inner cheeks and base of the clypeus. Margins of the pronotum rather broadly black both above and below, the black being continued around the humeral angles for a little way. Apical lobe of the scutellum infuscated. Elytra salmon-yellow; a straight commissural vitta covering about one-third of their width and a subcostal line reaching nearly to the apex, black; cuneus pale, its extreme tip touched with fuscous. Beneath pale with a broad black vitta along each side, meeting on the genital segment. Legs pale, the hind tibiae infuscated or black; tarsi black at apex.

Redescribed from two female examples, one from Kingston, R. I., taken in August, the other taken by me at Hamburg, N. Y., July 10, 1898. The salmon color with the black median vitta and pronotal margins and the submarginal black line on the costa will readily distinguish this pretty species.

### 32. *Orthotylus candidatus*, new species.

Aspect of *formosus*, but smaller, more nearly allied to *submarginatus*. Almost white, a little tinged with yellow or fulvous; median line of the head and scutellum and the sides of the pronotum narrowly black. Length 5mm.

Head as in *formosus*, more oblique than in most of our species. Vertex considerably depressed, the basal carina prominent and conspicuous. Front polished, but little convex. Clypeus almost tumidly prominent, highly polished. Eyes large, viewed from the side oval and reaching nearly to the gula. Rostrum scarcely attaining the base of the intermediate coxæ. Pronotum as in *submarginatus*, the callosities large, little elevated, their inner margins parallel and closely approximated,

behind distinguished by a feebly arcuated conspicuous transverse impressed line. Basal lobe of the scutellum moderately exposed. Elytra subhyaline.

Color very pale testaceous, almost white, tinged with yellow on the pronotum, scutellum and legs, and with fulvous on the head, the basal carina of the vertex being of a deeper fulvous. Middle line of the vertex and front, a transverse line between the antennæ, narrow lateral margins of the pronotum, a median vitta on the scutellum, expanded on the basal lobe, and the slender scutellar and commissural edges of the clavus, black. Beneath with a broad percurrent black vitta on either side. Basal joint of the antennæ black; the second ferruginous, fuscous on apical third; third fuscous. Tips of the tibiæ and the tarsi darker. Elytra whitish-testaceous, subhyaline, with an obscure fuscous line inside the principal nervure; the apex of the costal area touched with fulvous. Membrane faintly infuscated, the nervure brownish, the surface of the areole milky-hyaline. Surface very minutely pale pubescent.

Described from a single female example taken by Mrs. Annie Trumbull Slosson on Mt. Washington, N. H. This interesting addition to our Capsid fauna may be distinguished by its whitish color marked with a black line on the vertex, scutellum, sides of the body beneath, and narrow lateral margins of the pronotum. The male is likely to be more broadly marked with black.

Type, female, in collection of Mrs. A. T. Slosson.

### 33. *Orthotylus necopinus*, new species.

Allied to *dorsalis*, but much larger and a little more widened posteriorly; dark fuscous brown with an obscure dorsal vitta and a pale arc at the base of the cuneus. Length  $6\frac{1}{2}$  mm. to tip of membrane.

Head as in *dorsalis*, the vertex much flattened, almost excavated before the very prominent basal carina. Front rather prominent, polished; clypeus less prominent than in the allied species, its incised base a little below the line of the antennæ. Eyes large, viewed from the side ovate and reaching nearly to the gula. Pronotum as in *dorsalis*, well narrowed anteriorly; callosities small, prominent; posterior lobe transversely rugose;

hind margin a little concave, leaving the basal lobe of the scutellum moderately exposed. Elytra gradually widened almost to the apex of the corium, the abdomen nearly attaining the tip of the cuneus. Tibial bristles short and weak, concolorous with the tibiæ. Rostrum short, hardly attaining the base of the intermediate coxæ.

Dextral hook of the male genitalia large, mushroom-shaped, with its distal margin oblique and parallel with the edge of the segment, its apices rounded; sinistral hook linear and strongly incurved; both hooks pale.

Color brownish-fuscous, becoming black on the front of the head and along either side of the body beneath. Base of the vertex, an elongated spot against the inner margin of each eye and the median line pale or greenish. Anterior margin of the pronotum before the callosities and the middle of the posterior disk pale or greenish, the anterior margin sometimes tinged with ferruginous. Median vitta of the scutellum pale or somewhat ferruginous. Commissural and costal nervures slenderly pale; a pale ray on the base of the corium within the costa extending a little beyond the tip of the scutellum, and a less conspicuous commissural mark from the tip of the clavus to the base of the membrane; incisure at base of the cuneus pale. Membrane deeply infuscated with its nervures pale and with a whitish mark against the apex of the cuneus. Antennæ black. Rostrum and legs brownish-testaceous, the tarsi becoming black. Beneath black and polished with a broad indefinite whitish median vitta extending as far as the genital segment.

Described from one male taken on Mt. Washington, N. H., by Mrs. Annie Trumbull Slosson; a female taken on Mt. Washington, July 5, 1914, and sent to me by Mr. H. H. Knight; a female taken by me at Bretton Woods at the foot of Mt. Washington, June 30, 1909; and another taken at Spring Brook, near Buffalo, N. Y., June 25, 1911. The large size and dark brown color of this species will readily distinguish it. In the male the basal pale ray on the corium is considerably extended.

Type, male, in collection of Mrs. A. T. Slosson. Allotype, female, in collection of the author. Paratypes in Museum of

California Academy of Sciences (No. 328), collection of H. H. Knight, and author's collection.

34. *Orthotylus fumidus*, new species.

A large fuscous form clothed with gray pubescence. Length 6mm. to tip of membrane.

Head distinctly oblique; vertex scarcely flattened, the basal carina apparently wanting; front hardly convex, transversely striate; clypeus large, but little prominent; apex of the cheeks tumid. Eyes large, prominent; viewed from the side a little oblique, almost attaining the line of the gula. Pronotum moderately sloping, nearly flat, the sides almost rectilinear; callosities large, flat. Basal lobe of the scutellum narrowly exposed. Abdomen reaching to the tip of the cuneus. Legs long for this genus. Rostrum short, not attaining the base of the intermediate coxæ.

Color a uniform fuscous-brown, probably nearly black when fully mature; tinged with rufous on the head, apex of the pronotum, and base of the legs; sides of the venter with a black vitta. Membrane blackish, the nervures of the smaller areole pale. Whole surface clothed with short white deciduous hairs.

Described from one female example taken by me at Ft. Collins, Colo., July 28, 1898. This individual may be somewhat immature, but, while not typical of this genus, the species evidently belongs here and is included to complete the enumeration of our species, so far as they are known to me.

Type, female, in author's collection.

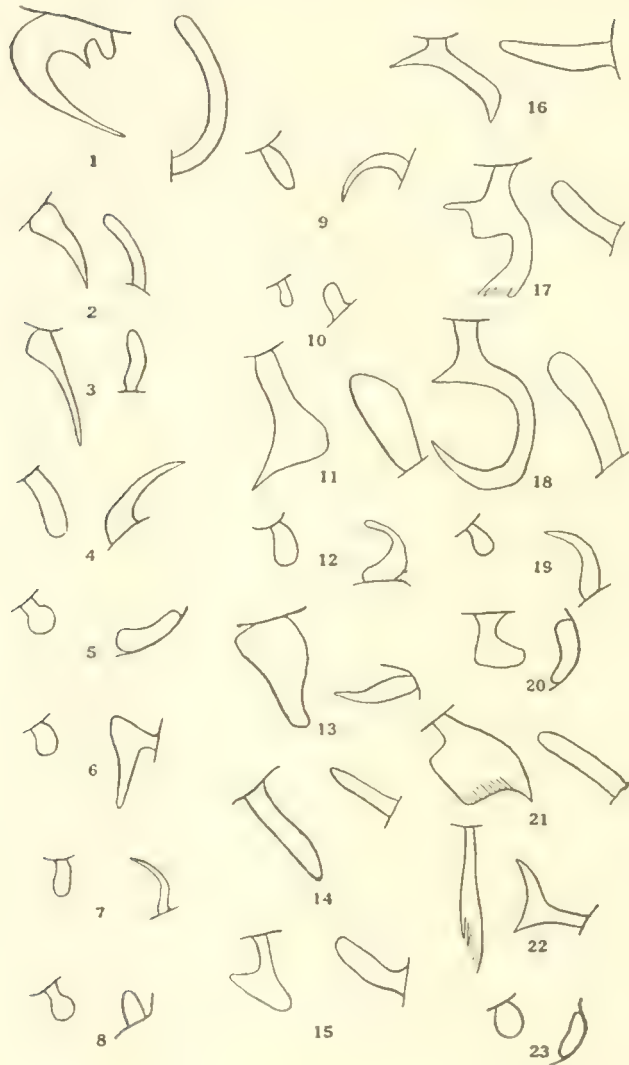


Fig. 1. Male genital hooks of the species of *Orthotylus*, as viewed from a point vertical to the plane of the hook.

1, *Orthotylus insignis*; 2, *tibialis*; 3, *ferox*; 4, *viridicatus*; 5, *coagulatus*; 6, *flavosparsus*; 7, *chlorionis*; 8, *fraternus*; 9, *uniformis*; 10, *translucens*; 11, *ovatus*; 12, *catulus*; 13, *languidus*; 14, *modestus*; 15, *dorsalis*; 16, *marginatus*; 17, *molliculus*; 18, *affinis*; 19, *brunneus*; 20, *pullatus*; 21, *cruciat*; 22, *lateralis*; 23, *cuneatus*.

PROCEEDINGS  
OF THE  
CALIFORNIA ACADEMY OF SCIENCES  
FOURTH SERIES

VOL. VI, No. 6, pp. 129-213.

MAY 12, 1916

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VI  
A CATALOGUE AND HOST LIST OF THE ANOPLURA

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INTRODUCTION

The Anoplura (sucking lice) have long been much neglected and much misunderstood, for as late as 1904 no critical, comparative study of the group had ever been made; and this in spite of the fact that the group had had a place in two monumental works upon parasitic insects, *Insecta Epizoa* of Giebel and *Les Pediculines* of Piaget. With the exception of a few forms of such peculiar nature that they were almost of necessity given generic rank, the species were for the most part lumped under the genus *Hæmatopinus* and all were regarded as forming a single family, the Pediculidæ. In 1904, Enderlein, in a series of "*Lauscestudien*" published in the *Zoologischer Anzeiger*, broke up the all-inclusive genus *Hæmatopinus* into several genera and elevated this group, as well as certain other groups, to family rank.

There has been some objection to this procedure, but on the whole it has been amply justified by time. The old classification was based upon lack of knowledge and served only successfully to conceal a wealth of remarkably interesting bio-

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logical facts that the newer classification has revealed and emphasized. The remarkable degree to which these parasites are broken up into natural groups that are strictly confined to closely related groups of hosts, is now clearly evident, while previously it was barely hinted at. The problem of their distribution is shown to be almost exclusively the problem of the genetic relationships of their hosts.

In 1908 there appeared, as a part of Wytsman's *Genera Insectorum*, a catalogue, compiled by Dalla Torre, based upon the work of Enderlein. This catalogue has proved of immense value, but the knowledge of the Anoplura has increased so rapidly since its publication that the additions and corrections have now attained a bulk almost rivaling the original catalogue, and it therefore seems well that a new catalogue should be issued.

These changes and additions may briefly be summarized. Since 1909 nine valid genera have been added to the list and approximately 60 species have been described (the previous catalogue listed 65, the present one lists 120). The position of numerous species then in doubt has since been cleared up and many of the question marks have been removed, this being the case especially with the North American species described by Osborn, almost all of which were then in doubt but have since been cleared up. More significant, perhaps, than the description of new genera and species is the improved standard of work that has been established. The magnificent "Monographie der Robbenläuse" of Enderlein, in the report of the "Deutsche Südpolar Expedition," and the careful and critical work of Fahrenholz, Cummings, and Neumann, form a splendid contrast to the superficial and often inaccurate work that formerly prevailed.

The synonymy of many of the hosts and some of the parasite species is still badly tangled. The hosts have frequently been referred to only by their vernacular names and when the scientific names have been used they have sometimes been inaccurate, added to which the instability of mammal nomenclature has not been conducive to clearness. The synonymy of the North American mammals has in part been worked out from the "List of North American Land Mammals in the United States National Museum" (Miller, 1911), and, in ad-

dition, the authorities of the Museum of Vertebrate Zoology of the University of California have been extremely kind in helping to clear up numerous matters. The synonymy of the European mammals has been worked out from the "Catalogue of the Mammals of Europe" (Miller, 1912). The synonymy of the Primates has been taken from Elliot's "A Review of the Primates" (1912), but it is very probably still far from correct. The synonymy of other species, when not obtainable elsewhere, has been reduced to the basis of Trouessart's "Catalogus Mammaliun" (1899), although it has been necessary to do this only in the case of some of the older species. The host names given in the list of Anoplura are as nearly as can be determined the correct ones. In the host list the names in parentheses are regarded as synonyms, the others are correct as far as available information permits. An attempt has been made to list all the host names that have at any time been used.

#### SYSTEMATIC POSITION OF THE ANOPLURA

*Anoplura* Leach, Edinburgh Encyclopedia (1817); Enderlein, Zool. Anz., vol. 28, pp. 121-147 (1904); Mjöberg, Ark. f. Zool., vol. 6, pt. 13 (1910); Cummings, An. Mag. Nat. Hist., ser. 8, vol. 15, pp. 256-259 (1915).

*Pediculinæ* Burmeister, Handbuch d. Ent., vol. 2, p. 52 (1835).

*Siphunculata* Meinert, Videnskabelige Meddelelser (1896); Cholodkovsky, Zool. Anz., vol. 27, p. 527 (1904).

*Pseudorhyncota* Cholodkovsky, Zool. Anz., vol. 27, p. 125 (1903).

*Lipognatha* Börner, Zool. Anz., vol. 27, p. 527 (1904).

*Ellipoptera* Shipley, *ibid.*, vol. 27, p. 261 (1904).

The systematic position of the Anoplura has always been a matter of doubt and dispute. Because of their parasitic habits they were for a long time classed with the Mallophaga, but later under the influence of the "biting- or sucking-mouth-parts" fetish, the two groups were separated and the Anoplura were placed with the Hemiptera, of which they have for some time been regarded as a suborder most frequently known as Parasita. Their position here has quite generally been re-

garded as rather definitely fixed, but within the last few years evidence has been found which indicates that a readjustment is again desirable.

Handlirsch and Cholodkovsky have favored an arrangement which restores the Anoplura and Mallophaga to a position very similar to that which they originally held in relation to each other, and other authors have brought forward evidence in support of this view. As a result of a comparative study of the two groups Mjöberg has concluded that they are really quite closely related, the Anoplura being merely a further adaptation to a parasitic life, and with this view Kellogg and Cummings are inclined to agree. Enderlein alone, of recent authors, has contended for retaining the Anoplura as a sub-order of Hemiptera. The evidence is too voluminous to be reviewed here, but it indicates very strongly that the Anoplura really have nothing to do with the Hemiptera and are related to the Mallophaga. It seems best to regard the Anoplura as a distinct order and in the latest classification of the Insecta, that of Brues and Melander, this is done. However, the problem of their relationships is still an open question which can only be settled by much more careful comparative morphological studies.

The classification within the order itself is extremely simple; too little is known about the group for the classification to be otherwise. Four families, all of which apparently form quite natural groups, are recognized. Of these, one, *Hæmatomyzidæ*, contains a single remarkable species (with a possible variety) which occurs upon elephants. Another small family, *Echinophthiriidæ*, is limited in its occurrence to marine mammals, its peculiarities being ascribable to adaptation to the aquatic life of the hosts. The *Pediculidæ* include the species found upon man, apes and monkeys, and the remainder of the species are contained in the family *Hæmatopininæ*.

Nearly as many species have been described since 1908 as had been described previous to that time, but in spite of this activity the study of the group has hardly begun. The host list, when compared with a list of the mammals of the world, is pitifully small, as is instanced by the fact that there are but four records of Anoplura from mammals of the South Ameri-

can region. It is certainly not unsafe to estimate that the number of known species is not more than one-fifth of those that actually exist.

## KEY

## TO FAMILIES, SUBFAMILIES AND GENERA OF ANOPLURA.

- 1—Body thickly beset with more or less short, stout spines, or with spines and scales. Occurring exclusively on marine mammals. Family ECHINOPHTHIRIDÆ..... 2  
     Body with spines or hairs always in definite rows, never with scales. Occurring exclusively on land mammals ..... 4
- 2—Thorax and abdomen bearing delicate scales. Antennæ four- or five-segmented. Subfamily ANTARCTOPHTHIRIINÆ ..... 3  
     Thorax and abdomen without scales. Antennæ four-segmented.  
     Subfamily ECHINOPHTHIRIINÆ..Genus *Echinophthirus*
- 3—Antennæ four-segmented.....Genus *Lepidophthirus*  
     Antennæ five-segmented.....Genus *Antarctophthirus*
- 4—Head tubularly produced anteriorly; tibiæ without a thumb-like process opposing the claw. Family HÆMATOMYZIDÆ. One genus, *Hæmatomyzus*, occurring on elephants.  
     Head not so produced; tibiæ with thumb-like process opposing the claw..... 5
- 5—Eyes lacking. Family HÆMATOPINIDÆ..... 9  
     Eyes present, well pigmented. Occurring on man, apes and monkeys. Family PEDICULIDÆ..... 6
- 6—Antennæ distinctly five-segmented, abdomen without pleural plates. Subfamily PEDICULINÆ..... 8  
     Antennæ three-segmented or obscurely five-segmented, abdomen with pleural plates. Subfamily PEDICININÆ ..... 7
- 7—Legs all with slender, pointed claws, abdomen with three pairs of pleural plates.....Genus *Pedicinus*  
     Anterior legs with slenderer claw than the others, abdomen with two pairs of pleural plates.....  
     .....Genus *Phthirpedicinus*

- 8—Legs all of same size.....Genus *Pediculus*  
 Anterior legs much smaller than others...Genus *Phthirus*
- 9—Antennæ five-segmented.....11  
 Antennæ three-segmented. Subfamily EUHÆMATOPININÆ.....10
- 10—Posterior legs with stalked, disk-shaped appendages on femur and tibia.....Genus *Euhæmatopinus*  
 Posterior legs without such appendages.....  
 ..... Genus *Hæmatopinoides*
- 11—Legs and claws all practically of equal size.....  
 Subfamily HÆMATOPININÆ.....Genus *Hæmatopinus*  
 Anterior legs smaller and with slenderer claw than the posterior pair, at least. Subfamily LINOGNATHINÆ..12
- 12—Anterior tarsi with two joints.....Genus *Hybophthirus*  
 Anterior tarsi with but one joint.....13
- 13—Anterior tarsi with a short, claw-like process in addition to the claw.....Genus *Scipio*  
 Anterior tarsi not so.....14
- 14—Abdomen with well developed pleural plates.....18  
 Abdomen entirely without pleural plates.....15
- 15—Abdomen with more than one row of hairs or spines on each segment.....Genus *Linognathus*  
 Abdomen with but one row of hairs on each segment..16
- 16—Gonapods moderately long, behind each gonapod a stout, flat, spine-like process.....Genus *Cervophthirus*  
 Gonapods very short, no flat, spine-like process behind them.....Genus *Hæmodipsus* (in part)
- 18—Anterior pair of legs equal to middle pair, both pairs very small, posterior pair large and stout.....  
 .....Genus *Enderleinellus*  
 Anterior legs smaller than either middle and posterior legs and with much smaller and more slender claw.19
- 19—Second or third abdominal sternite with a chitinized plate or area near each lateral margin.Genus *Fahrenholzia*  
 Second or third abdominal sternite without such plates .....20
- 20—Abdominal segments with but a single transverse row of spines.....21  
 Abdominal segments, at least in part, with two or more transverse rows of spines.....22

- 21—Occiput deeply sunk into the thorax, rostrum surrounded by denticles, pleural plates quite large.....  
 .....Genus *Eulinognathus*  
 Occiput not deeply sunk into the thorax, rostrum not surrounded by denticles, pleural plates minute....  
 .....Genus *Hæmodipsus* (in part)
- 22—Abdominal tergites and sternites with not more than two rows of hairs or spines.....23  
 Abdominal tergites and sternites in part with three rows of hairs or spines.....Genus *Hoplopleura*
- 23—First antennal segment with a short, stout spine at the distal post axial angle or on the posterior margin....  
 .....Genus *Neohæmatopinus* (in part)  
 First antennal segment not so.....24
- 24—Posterior margin of second abdominal tergite of male distinctly emarginate with a group of spines at each end of this emargination...Genus *Neohæmatopinus* (in part)  
 Posterior margin of second abdominal tergite of male not thus emarginate.....25
- 25—Abdomen with distinct, chitinized tergal and sternal plates in both sexes.....Genus *Polyplax*  
 Abdomen without distinct, chitinized tergal and sternal plates in the female and with these absent or extremely reduced in size in the male...Genus *Linognathoides*

#### Family *Pediculidæ*

Leach, Zool. Misc., Vol. 3, p. 64 (1817); Giebel, Insecta Epizoa, p. 21 (1874); Piaget, Les Ped., pp. 615-618 (1880); Enderlein, Zool. Anz., Vol. 28, p. 136 (1904); Dalla Torre, Gen. Ins., Anopl., p. 8 (1908).

Antennæ five- or three- (obscurely five-) segmented. Eyes present, distinctly pigmented. Legs fitted for climbing, the tibiæ with a thumb-like process opposing the claw. No pretarsal sclerite between tibia and tarsus. Parasitic upon man, apes, and monkeys.

#### Subfamily *Pediculinæ*

Enderlein, Zool. Anz., Vol. 28, pp. 136, 138 (1904); Dalla Torre, Gen. Ins., Anopl., p. 8 (1908).

Antennæ distinctly five-segmented. No pleural plates.

Genus *Pediculus* Linnæus

Linnæus, *Systema Naturæ*, ed. 10, p. 610 (1758); Denny, *Mon. Anopl.*, pp. 12-13 (1842); Giebel, *Ins. Epizoa*, pp. 27-30 (1874); Piaget, *Les Ped.*, pp. 619-623 (1880); Enderlein, *Zool. Anz.*, Vol. 28, pp. 136, 138 (1904).

Head short. Legs all of approximately the same size. Abdomen elongated. Spiracles small. Abdominal segments without lateral projections, and with numerous small spines.

Type of the genus *P. capitis* De Geer.

- 1—*Pediculus mjöbergi*, new name. From *Ateleus* sp.? (traveling menagerie, Europe).

1910. *Pediculus affinis* (not of Burmeister), Mjöberg, *Ark. f. Zool.*, Vol. 6, pt. 13, pp. 169-171, f. 85.

- 2—*Pediculus capitis* De Geer. From man. Also recorded from *Ateleus ater* (locality unknown) and from *Cebus fatuellus* and *Cebus* sp. (Rio de Janeiro, S. America).

1758. *Pediculus humanus* Linnæus, *Syst. Naturæ*, 10th ed., p. 610.

1778. *Pediculus humanus* var. I, Linnæus, *ibid.*, 12th ed., Vol. 2, p. 1016.

1778. *Pediculus humanus* var. *capitis* De Geer, *Mem. Hist. Ins.*, Vol. 7, p. 67; pl. 1, f. 6.

1817. *Pediculus cervicalis* Leach, *Zool. Misc.*, Vol. 3, p. 66.

1818. *Pediculus capitis* Nitzsch, *German's Mag.*, Vol. 3, p. 305.

1842. *Pediculus capitis* Denny, *Mon. Anopl.*, pp. 13-16; pl. 26, f. 2.

1874. *Pediculus capitis* Giebel, *Ins. Epizoa*, pp. 30-32; pl. 1, f. 1-2.

1880. *Pediculus capitis* Piaget, *Les Ped.*, pp. 619-623; pl. 50, f. 2.

1912. *Pediculus capitis* Fahrenholz, *Jahresb. d. Niedersäch. Zool. Ver.*, pp. 2-12: f. 1, 3, 7, pl. 3, f. 3-4.

- 3—*Pediculus consobrinus* Piaget. From *Ateleus paniscus* (Museum Leyden).

1880. *Pediculus consobrinus* Piaget, *Les. Ped.*, pp. 626-628; pl. 51, f. 4.

1908. *Pediculus consobrinus* Dalla Torre, Gen. Ins. Anopl., p. 8.  
1911. *Pediculus consobrinus* Neumann, Arch. de Par., Vol. 14, pp. 412-413.

NOTE: This species is very doubtfully distinct from *Pediculus capitis*.

4—*Pediculus corporis* De Geer. From man.

1758. *Pediculus humanus* Linnæus, Syst. Nat., 10th ed., p. 610.  
1766. *Pediculus humanus* var. 2 Linnæus, ibid., 12th ed., Vol. 2, p. 1016.  
1778. *Pediculus humanus* var. *corporis* De Geer, Mem. Hist. Ins., Vol. 7, p. 67; pl. 1, f. 7.  
1818. *Pediculus vestimenti* Nitzsch, Germar's Mag., Vol. 3, p. 305.  
1842. *Pediculus vestimenti* Denny, Mon. Anopl., pp. 16-18; pl. 26, f. 1.  
1874. *Pediculus vestimenti* Giebel, Ins. Epizoa, pp. 27-30; pl. 1, f. 5.  
1880. *Pediculus vestimenti* Piaget, Les. Ped., pp. 623-625; pl. 5, f. 3.  
1908. *Pediculus corporis* Dalla Torre, Gen. Ins., Anopl., p. 8.  
1911. *Pediculus capitis* var. *vestimenti* Neumann, Arch. de Par., Vol. 14, pp. 411-412.  
1912. *Pediculus corporis* Fahrenholz, 2-3-4th Jahresb. d. Niedersäch. Zool. Ver., pp. 2-12; f. 2; pl. 3, f. 1-2.

5—*Pediculus lobatus* Fahrenholz. From *Atcleus pan* (Berlin Museum).

1913. *Pediculus lobatus* Fahrenholz (without description), Zool. Anz., Vol. 41, p. 373.

6—*Pediculus oblongus* Fahrenholz. From *Hylobates concolor* and *Hylobates syndactylus*.

1913. *Pediculus oblongus* Fahrenholz (without description), Zool. Anz., Vol. 41, p. 373.

7—*Pediculus schäffi* Fahrenholz. From *Pan* sp.?

1910. *Pediculus schäffi* Fahrenholz, Zool. Anz., Vol. 35, p. 714.

Genus *Phthirus* Leach

*Phthirus* Leach, Edinburgh Encycl., Vol. 9, p. 77 (1815); Zool. Misc., Vol. 3, p. 64 (1817); Enderlein, Zool. Anz., Vol. 28, pp. 136, 138 (1904); Dalla Torre, Gen. Ins., Anopl., p. 9 (1908).

*Phthirus* Burmeister, Handbuch der Entomologie, Vol. 2, p. 1 (1835); Denny, Mon. Anopl., pp. 8-9 (1842); Giebel, Ins. Epizoa, pp. 23-27; pl. 1, f. 8 (1874); Piaget, Les Ped., pp. 628-630; pl. 51, f. 5 (1880).

Anterior legs much smaller and with much slenderer claws than the others. Abdomen short and broad, the fifth to eighth segments with conical lateral processes. Spiracles large, those of the first three abdominal segments crowded close together.

1—*Phthirus pubis* Linnæus. From man.

- 1758. *Pediculus pubis* Linnæus, Syst. Naturæ, ed. 10, p. 611.
- 1817. *Phthirus inguinalis* Leach, Edinburgh Encycl., Vol. 9, p. 77.
- 1818. *Pediculus tabescentium* Alt. De Phthiriasi.
- 1842. *Phthirus inguinalis* Denny, Mon. Anopl., pp. 9-11; pl. 26, f. 3.
- 1874. *Phthirus inguinalis* Giebel, Ins. Epizoa, pp. 23-27; pl. 1, f. 8.
- 1880. *Phthirus inguinalis* Piaget, Les Ped., pp. 628-630; pl. 51, f. 5.
- 1904. *Phthirus pubis* Enderlein, Zool. Anz., Vol. 28, p. 136.
- 1908. *Phthirus pubis* Dalla Torre, Gen. Ins., Anopl., p. 9.

Subfamily *Pedicininae*

Enderlein, Zool. Anz., Vol. 28, pp. 136, 138 (1904); Dalla Torre, Gen. Ins., Anopl., p. 9 (1908); Fahrenholz, Jahresb. d. Niedersäch. Zool. Ver., pp. 28-29 (1912).

Antennæ three-segmented or obscurely five-segmented. Head more or less elongated. Abdomen with a single row of many very small spines on each segment. Pleural plates present on certain abdominal segments.

NOTE: The synonymy of the species in this subfamily has been dealt with by Fahrenholz and, although it is still far from clear, his conclusions have been adopted here.

### Genus *Pedicinus* Gervais

Gervais, Aptères, Vol. 3, p. 301; pl. 48, f. 1 (1844); Giebel, Ins. Epizoa, pp. 32-33 (1874); Piaget, Les Ped., pp. 630-632 (1880); Dalla Torre, Gen. Ins., Anopl., p. 9 (1908); Fahrenholz, 2-3-4th Jahresb. d. Niedersäch. Zool. Ver., pp. 12-16 (1912).

All legs with slender, pointed claws of nearly the same size. Abdomen with three pairs of pleural plates.

Type of the genus *Pedicinus eurygaster* Piaget.

1—*Pedicinus breviceps* Piaget. From *Lasiopyga mona*. Also from *Cercopithecus*, sp., and *Pithecus albibarbatulus*.

1880. *Pedicinus breviceps* Piaget, Les Ped., pp. 632-633; pl. 52, f. 1.

1910. *Pedicinus breviceps* Mjöberg, Ark. f. Zool., Vol. 6, pt. 13, p. 172.

1912. *Pedicinus breviceps* Fahrenholz, 2-3-4th Jahresb. d. Niedersäch. Zool. Ver., p. 16, 28.

2—*Pedicinus eurygaster* (Burmeister). From *Pithecus nemes-trinus* and *Pithecus fascicularis*?

1838. *Pediculus eurygaster* Burmeister, Gen. Insectorum.

1880. *Pedicinus eurygaster* Piaget, Les Ped., p. 630; pl. 51, f. 6.

1908. *Pedicinus eurygaster* Dalla Torre, Gen. Ins., Anopl., p. 9.

1912. *Pedicinus eurygaster* Fahrenholz, 2-3-4th Jahresb. d. Niedersäch. Zool. Ver., pp. 12-15, 28.

3—*Pedicinus hamadryas* Mjöberg. Type from *Papio* sp.? (Zool. Mus. Hamburg).

1910. *Pedicinus hamadryas* Mjöberg, Ark. f. Zool., Vol. 6, pt. 13, pp. 172-174, f. 86-87.

4—*Pedicinus longiceps* Piaget. Type from *Pygathrix cristata*? Also from *Pithecus fascicularis*?

1880. *Pedicinus longiceps* Piaget, Les Ped., p. 632; pl. 51, f. 7.
1908. *Pedicinus longiceps* Dalla Torre, Gen. Ins., Anopl., p. 9.
1912. *Pedicinus longiceps* Fahrenholz, 2-3-4th Jahresb. d. Niedersäch. Zool. Ver., pp. 15, 28.
- 5—*Pedicinus paralleliceps* Mjöberg. From *Pithecus olbibarbatus* (Zool. Mus. Hamburg).
1910. *Pedicinus paralleliceps* Mjöberg, Ark. f. Zool., Vol. 6, pt. 13, pp. 174-176, f. 88.
- 6—*Pedicinus rhesi* Fahrenholz. From *Pithecus rhesus*.
1912. *Pedicinus rhesi* Fahrenholz, Zool. Anz., Vol. 39, p. 54.
1912. *Pedicinus rhesi* Fahrenholz, 2-3-4th Jahresb. d. Niedersäch. Zool. Ver., pp. 15-22; pl. 1, f. 4, 5; pl. 3, f. 6

#### Genus *Phthirpedicinus* Fahrenholz

Fahrenholz, Zool. Anz., Vol. 39, pp. 54-55 (1912), 2-3-4th Jahresb. d. Niedersäch. Zool. Ver., pp. 22-23.

Anterior legs with slender, pointed claw, others with short, blunt claws. Abdomen with two pairs of pleural plates.

Type of the genus *Phthirpedicinus micropilosus* Fahrenholz.

- 1—*Phthirpedicinus micropilosus* Fahrenholz. From *Pithecus rhesus*.
1912. *Phthirpedicinus micropilosus* Fahrenholz, Zool. Anz., Vol. 39, p. 55.
1912. *Phthirpedicinus micropilosus* Fahrenholz, 2-3-4th Jahresb. d. Niedersäch. Zool. Ver., pp. 22-23; pl. 1, f. 1-3.
- 2—*Phthirpedicinus microps* (Nitzsch). From *Pithecus sinicus*.
1838. *Pediculus eurygaster* Burmeister, Gen. Ins.
1864. *Pediculus microps* Nitzsch, Giebel, Zeit. f. ges. Naturw., Vol. 23, p. 32.
1874. *Pedicinus eurygaster* Giebel, Ins. Epizoa, pp. 32-33.
1912. *Phthirpedicinus microps* Fahrenholz, Zool. Anz., Vol. 39, p. 55.

1912. *Phthirpedicinus microps* Fahrenholz, 2-3-4th Jahresb. d. Niedersäch. Zool. Ver., pp. 13, 26, 28.
- 3—*Phthirpedicinus piageti* (Stroebelt). From *Pithecus brevicaudatus* or *P. rhesus*.
1881. *Pedicinus piageti* Stroebelt, Jahresb. d. westf. Ver. f. Wissensch. u. Kunst, Vol. 9, p. 82; pl. 1, f. 3.
1908. *Pedicinus piageti* Dalla Torre, Gen. Ins., Anopl., p. 9.
1912. *Phthirpedicinus piageti* Fahrenholz, 2-3-4th Jahresb. d. Niedersäch. Zool. Ver., p. 28.

Pediculidæ of uncertain position

*Pedicinus graciliceps* Piaget. From unknown host.

1885. *Pedicinus graciliceps* Piaget, Les Ped., Suppl., p. 141; pl. 15, f. 4.
1912. *Pedicinus?* *graciliceps* Fahrenholz, 2-3-4th Jahresb. d. Niedersäch. Zool. Ver., pp. 20, 29.

NOTE: Fahrenholz regards this species as probably belonging to an undescribed genus, characterized chiefly by the presence of five pairs of pleural plates.

*Hæmatopinus albidus* Rudow. From *Simia sylvanus*.

1869. *Hæmatopinus albidus* Rudow, Zeit. f. d. ges. Naturw., Vol. 34, p. 169.
1912. *Hæmatopinus?* *albidus* Fahrenholz, 2-3-4th Jahresb. d. Niedersäch. Zool. Ver., p. 29.

NOTE: Judging from the host, this probably belongs to the subfamily *Pedicininae*. The genus cannot be determined.

*Hæmatopinus obtusus* Rudow. From *Pygathrix aurata?*

1869. *Hæmatopinus obtusus* Rudow, Zeit. f. d. ges. Naturw., Vol. 34, p. 169.
1908. *Hæmatopinus?* *obtus* Dalla Torre, Gen. Ins., Anopl., p. 11.

NOTE: This probably belongs to the *Pediculidæ*.

Family *Hæmatopinidæ*

Enderlein, Zool. Anz., Vol. 28, pp. 136, 137 (1904); Dalla Torre, Gen. Ins., Anopl., p. 10 (1908).

Eyes lacking. Antennæ three- or five-segmented. Tibiæ with a thumb-like process opposing the claw.

Subfamily *Hæmatopiniæ*

Enderlein, Zool. Anz., Vol. 28, pp. 136, 138 (1904); Dalla Torre, Gen. Ins., Anopl., p. 10 (1908).

Antennæ five-segmented. Anterior legs of practically the size of the others. A triangular skeletal piece (pre-tarsal sclerite) present between tibia and tarsus.

Genus *Hæmatopinus* Leach

Leach, Zool. Misc., Vol. 3, pp. 64-65, f. 146 (1817); Denny, Mon. Anopl., pp. 24-25 (1842); Giebel, Ins. Epizoa, pp. 33-35 (1874); Piaget, Les Ped., pp. 633-635 (1880); Enderlein, Zool. Anz., Vol. 28, p. 138 (1904); Neumann, Arch. de Par., Vol. 13, pp. 529-532 (1909); Dalla Torre, Gen. Ins., Anopl., p. 10 (1908); Kellogg & Ferris, Anopl. and Mall., p. 10 (1915).

Head with very sharp, forward pointing temporal angles. Thorax broad. Legs all of practically the same size, with a strongly chitinized skeletal piece between tibia and tarsus. Abdomen with a swollen, pad-like, chitinized area on the lateral margins of the third to eighth segments. Tergites and sternites with a varying number of small chitinized plates. Each tergite and sternite with one transverse row of very small hairs.

Recorded from *Perissodactyla* and *Artiodactyla*.

Type of the genus, *Hæmatopinus suis* (Linnæus).

1—*Hæmatopinus asini* (Linnæus). From the domestic horse and the ass (cosmopolitan). Also from *Equus burchelli* (Zool. Mus. Hamburg).

1758. *Pediculus asini* Linnæus, Syst. Nat., 10th ed., p. 612.

1829. *Hæmatopinus asini* Stephens, Catalogue, Vol. 2, p. 329.
1838. *Pediculus macrocephalus* Burmeister, Gen. Rhyn. No. 18.
1842. *Hæmatopinus asini* Denny, Mon. Anopl., pp. 32-33; pl. 25, f. 1.
1865. *Hæmatopinus equi* Simmonds, Journ. Ag. Soc. Lond. (2), Vol. 1, pp. 60-62.
1874. *Hæmatopinus macrocephalus* Giebel, Ins. Epizoa, pp. 44-45; pl. 2, f. 5.
1880. *Hæmatopinus macrocephalus* Piaget, Les Ped., pp. 652-653; pl. 53, f. 3.
1891. *Hæmatopinus asini* Osborn, Bul. 7, o. s., U. S. Dept. Agr., Div. Ent., pp. 21-22, f. 9.
1896. *Hæmatopinus asini* Osborn, Bul. 5, n. s., pp. 180-181, f. 103.
1904. *Hæmatopinus asini* Enderlein, Zool. Anz., Vol. 28, p. 141.
1908. *Hæmatopinus asini* Dalla Torre, Gen. Ins., Anopl., p. 10.
1910. *Hæmatopinus asini* Mjöberg, Ark. f. Zool., Vol. 6, pt. 13, p. 167.
- 1a—*Hæmatopinus asini* var. *colorata* Piaget. From *Equus asinus*. (Europe).
1880. *Hæmatopinus macrocephalus* var. *colorata* Piaget, Les Ped., p. 654.
- 2—*Hæmatopinus bufali* (De Geer). From *Buffelus caffer*. (Congo Free State and Nyasaland, Africa).
1778. *Pediculus bufali* De Geer, Histoire des Ins., Vol. 7, p. 68; pl. 1, f. 11, 12.
1844. *Pediculus phthiriopsis* Gervais, Apteres, Vol. 3, p. 306.
1874. *Hæmatopinus phthiriopsis* Giebel, Ins. Epizoa, p. 47.
1880. *Hæmatopinus phthiriopsis* Piaget, Les Ped., p. 652.
1904. *Hæmatopinus phthiriopsis* Enderlein, Zool. Anz., Vol. 28, p. 141.
1908. *Hæmatopinus phthiriopsis* Dalla Torre, Gen. Ins., Anopl., p. 11.

1909. *Hæmatopinus bufali* Neumann, Arch. de Par., Vol. 13, pp. 500-505, f. 2-5.
1910. *Hæmatopinus phthiriopsis* Mjöberg, Ark. f. Zool., Vol. 6, pt. 13, p. 166.
- 3—*Hæmatopinus curysternus* (Nitzsch). From *Bos taurus*.
1818. *Pediculus curysternus* Nitzsch, Germar's Mag., Vol. 3, p. 305.
1842. *Hæmatopinus curysternus* Denny, Mon. Anopl., pp. 29-30; pl. 25, f. 5.
1864. *Pediculus curysternus* Nitzsch, Zeit. f. ges. Naturw., Vol. 23, p. 27.
1874. *Hæmatopinus curysternus* Giebel, Ins. Epizoa, pp. 41-42; pl. 2, f. 8.
1880. *Hæmatopinus curysternus* Piaget, Les Ped., pp. 648-650; pl. 53, f. 1.
1885. *Hæmatopinus tuberculatus* var. *penicillatus* Piaget, Les Ped., Suppl., p. 146.
1891. *Hæmatopinus curysternus* Osborn, Bul. 7, o. s., U. S. Dept. Agr., Div. Ent., pp. 13-16, f. 6.
1896. *Hæmatopinus curysternus* Osborn, Bul. 5, n. s., U. S. Dept. Agr., Div. Ent., pp. 172-175, f. 100.
1908. *Hæmatopinus curysternus* Dalla Torre, Gen. Ins., Anopl., p. 11.
1909. *Hæmatopinus curysternus* Neumann, Arch. de Par., Vol. 13, 1.c., pp. 498-500.
- 4—*Hæmatopinus longus* Neumann. From *Cervus unicolor*. (Nepaul, India).
1912. *Hæmatopinus longus* Neumann, Bul. Soc. Zool. France, Vol. 37, pp. 141-142, f. 1-4.
- 5—*Hæmatopinus* ? *oviformis* Rudow. From *Hircus magnificus*.
- (This name does not appear in available catalogues of mammals).
1869. *Hæmatopinus oviformis* Rudow, Zeit. f. ges. Naturw., Vol. 34, p. 170.
1874. *Hæmatopinus oviformis* Giebel, Ins. Epizoa, p. 47.
1880. *Hæmatopinus oviformis* Piaget, Les Ped., p. 648.

1908. *Hæmatopinus* ? *oviformis* Dalla Torre, Gen. Ins., Anopl., p. 11.
- 6—*Hæmatopinus phachochoeri* Enderlein. Type from *Phachochoerus ocliani massaicus*. (Kilimandjaro). Also from *Phachochoerus*, sp., *Potamochoerus choeropotamus* and *P. africanus*, *P. affinis nyasæ*. (German E. Africa and S. Africa).
1908. *Hæmatopinus phachochoeri* Enderlein, Swed. Exp. Kilimandjaro-Meru, Vol. 2, pt. 11, pp. 7-9, fig.
1909. *Hæmatopinus latus* Neumann, Arch. de Par., Vol. 13, pp. 505-508, f. 6-9.
1911. *Hæmatopinus peristictus* Kellogg & Paine, Bul. Ent. Res., Vol. 2, pp. 145-146; pl. 4, f. 3-6.
1912. *Hæmatopinus phachochoeri* Paine, Ent. News, Vol. 23, p. 468.
1912. *Hæmatopinus phachochoeri* Harms, Zool. Anz., Vol. 40, p. 293, f. 3.
1912. *Hæmatopinus incisus* Harms, Ibid., pp. 290-292, f. 12.
1916. *Hæmatopinus phachochoeri* Ferris, Ann. Durban Mus., Vol. 2 (in press).
- NOTE: This possibly contains two species; if so, they should stand as *Hæmatopinus phachochoeri* Enderlein and *Hæmatopinus peristictus* Kellogg & Paine.
- 7—*Hæmatopinus punctatus* (Rudow). From *Bos grunniens*.
1869. *Pediculus punctatus* Rudow, Zeit. f. ges. Naturw., Vol. 34, p. 167.
1874. *Hæmatopinus punctatus* Giebel, Ins. Epizoa, p. 47.
1880. *Hæmatopinus tuberculatus* var. *punctatus* Piaget, Les Ped., p. 652.
1908. *Pediculus* ? *punctatus* Dalla Torre, Gen. Ins., Anopl., p. 9.
1910. *Hæmatopinus punctatus* Mjöberg, Ark. f. Zool., Vol. 6, pt. 13, p. 166-167.
- 8—*Hæmatopinus suis* (Linnæus). From domestic swine. (Cosmopolitan).
1634. *Pediculus urius* Moufet, Theatrum Ins., p. 266.

1758. *Pediculus suis* Linnæus, Syst. Nat. (10th ed.), p. 611.
1817. *Hæmatopinus suis* Leach, Zool. Misc., Vol. 3, p. 65; pl. 146.
1818. *Pediculus urius* Nitzsch, Germar's Mag., Vol. 3, p. 305.
1842. *Hæmatopinus suis* Denny, Mon. Anopl., pp. 34-35; pl. 25, f. 2.
1847. *Hæmatopinus suis* Burmeister, Linnea. Entomol., Vol. 2, p. 577; pl. 1.
1874. *Hæmatopinus urius* Giebel, Ins. Epizoa, pp. 45-46; pl. 2, f. 6.
1880. *Hæmatopinus urius* Piaget, Les Ped., pp. 654-656; pl. 48, f. 4.
1891. *Hæmatopinus urius* Osborn, Bul. 7, o. s., U. S. Dept. Agr., Div. Ent., pp. 18-21, f. 8.
1896. *Hæmatopinus urius* Osborn, Bul. 5, n. s., U. S. Dept. Agr., Div. Ent., pp. 178-180, f. 102.
1904. *Hæmatopinus suis* Enderlein, Zool. Anz., Vol. 28, p. 124.
1908. *Hæmatopinus suis* Dalla Torre, Gen. Ins., Anopl., p. 11.
1911. *Hæmatopinus suis* Neumann, Arch. de Par., Vol. 14, pp. 406-490, f. 8a.
- 8a—*Hæmatopinus suis* var. *adventicius* Neumann. From *Sus vittatus* (East Indies).
1911. *Hæmatopinus suis* var. *adventicius* Neumann, Arch. de Par., Vol. 14, pp. 406-410, f. 8b.
- 9—*Hæmatopinus taurotragi* Cummings. From *Taurotragus oryx*. (Menagerie, Eng.)
1914. *Hæmatopinus taurotragi* Cummings, Bul. Ent. Res., Vol. 5, pp. 155-159, f. 1-2.
- 10—*Hæmatopinus tuberculatus* (Burmeister). Type from "Common buffalo or buffalo of India" (Vienna), also from "Buffalo of India, Tonkin, Summatra and Rumania," *Bison bison* (North America), *Camelus dromedarius* (India) and African camels.
1668. *Piddochio del cammello* Redi, Esperienze intorno alla generatione degl' insetti, pl. 20.

1758. *Pediculus cameli* Linnæus, *Systema Naturæ*, ed. 10, p. 611.
1839. *Pediculus tuberculatus* Burmeister, *Gen. Rhyn.*, No. 20.
1844. *Pediculus cameli* Gervais, *Apteres*, Vol. 3, p. 306.
1852. *Hæmatopinus tuberculatus* Lucas, *Ann. Ent. Soc. France*, Vol. 10, ser. 2, pp. 529-533; pl. 11, No. 2.
1864. *Pediculus tuberculatus* Nitzsch, *Zeit. f. ges. Naturw.*, Vol. 23, p. 32.
1867. *Hæmatopinus tuberculatus* Nitzsch, *Ibid.*, Vol. 28, p. 397.
1874. *Hæmatopinus cameli* Giebel, *Ins. Epizoa*, p. 47.
1874. *Hæmatopinus tuberculatus* Giebel, *Ibid.*, pp. 46-47.
1880. *Hæmatopinus cameli* Piaget, *Les Ped.*, p. 644.
1880. *Hæmatopinus tuberculatus* Piaget, *Ibid.*, pp. 650-652; pl. 53, f. 2.
1904. *Hæmatopinus tuberculatus* Enderlein, *Zool. Anz.*, Vol. 28, p. 140.
1908. *Hæmatopinus* ? *cameli* Dalla Torre, *Gen. Ins., Anopl.*, p. 11.
1908. *Hæmatopinus tuberculatus* Dalla Torre, *Ibid.*, p. 11.
1909. *Hæmatopinus tuberculatus* Neumann, *Arch. de Par.*, Vol. 13, pp. 497-500, f. 1.
1910. *Hæmatopinus tuberculatus* Mjöberg, *Ark. f. Zool.*, Vol. 6, pt. 13, p. 167.
1911. *Hæmatopinus tuberculatus* Neumann, *Arch. de Par.*, Vol. 14, pp. 413-414.

Subfamily *Linognathinæ*.

*Trichaulinæ* Enderlein, *Zool. Anz.*, Vol. 28, p. 138 (1904).

*Linognathinæ* Enderlein, *Zool. Anz.*, Vol. 29, p. 194 (1905).; Dalla Torre, *Gen. Ins., Anopl.*, p. 11 (1908).

Antennæ five-segmented. Anterior legs always distinctly smaller and with much slenderer claw than the posterior. No skeletal piece (pre-tarsal sclerite) between tibia and tarsus.

Genus *Enderleinellus* Fährénholz

Fährénholz, Zool. Anz., Vol. 39, p. 56 (1912); 2-3-4th Jahresb. d. Niedersäch. Zool. Ver., pp. 52-58 (1912); Kellogg and Ferris, Anopl. & Mall. of N. Am. Mam., p. 40 (1915).

Anterior and middle pairs of legs of equal size, small and with slender claws. Posterior legs very large and stout, with stout claw. Head entirely without temporal angles. Abdomen with or without chitinated tergal and sternal plates. Abdominal segments for the most part with but one row of hairs or spines in both male and female. Third sternite usually with a widely separated pair of chitinated plates or areas, one near each lateral margin. Pleurites present on second to fifth or sixth segments.

Recorded only from *Sciuridae* and *Petauristidae* (Rodentia).

Type of the genus *Enderleinellus sphaerocephalus* (Nitzsch).

- 1—*Enderleinellus kelloggi* Ferris. Type from *Sciurus griseus nigripes* (California, U. S. A.). Also from *S. griseus griseus* (California).

1916. *Enderleinellus kelloggi* Ferris, Psyche, Vol. 23 (in press).

- 2—*Enderleinellus longiceps* Kellogg & Ferris. Type from *Sciurus niger rufiventer* or *S. carolinensis* (Lincoln, Nebraska, U. S. A.). Also from *Sciurus niger rufiventer* (Indiana, U. S. A.) and *S. arizonensis huachuca* (Arizona, U. S. A.).

1915. *Enderleinellus longiceps* Kellogg & Ferris, Anopl. & Mall. of N. Am. Mam., pp. 44-46; pl. 2, f. 5; pl. 4, f. 12; pl. 6, f. 2.

1916. *Enderleinellus longiceps* Ferris, Psyche, Vol. 23 (in press).

- 3—*Enderleinellus osborni* Kellogg & Ferris. Type from *Citellus beecheyi* (California, U. S. A.). Also from *Citellus douglasi* (California).

1915. *Enderleinellus osborni* Kellogg & Ferris, Anopl. & Mall. of N. Am. Mam., pp. 43-44; t. f. 15; pl. 4, f. 11; pl. 6, f. 6.

- 4—*Enderleinellus sphaerocephalus* (Nitzsch). Type from *Sciurus vulgaris* (Europe). Also from *Sciurus hudsonicus*

*petulans* and *S. hudsonicus vancouverensis* (Alaska) and *S. douglasi albolimbatus* (California, U. S. A.).

1818. *Pediculus sphærocephalus* Nitzsch, Germar's Mag., Vol. 3, p. 305.
1842. *Hæmatopinus sphærocephalus* Denny, Mon. Anopl., p. 36.
1864. *Pediculus sphærocephalus* Nitzsch, Zeit. f. ges. Naturw., Vol. 23, p. 27.
1874. *Hæmatopinus sphærocephalus* Giebel, Ins. Epizoa, pp. 35-36; pl. 1, f. 4.
1880. *Hæmatopinus sphærocephalus* Piaget, Les Ped., p. 640-641.
1904. *Polyplax ? sphærocephala* Enderlein, Zool. Anz., Vol. 28, p. 143.
1908. *Polyplax ? sphærocephala* Dalla Torre, Gen. Ins., Anopl., p. 14.
1910. *Polyplax ? sphærocephala* Mjöberg, Ark. f. Zool., Vol. 6, pt. 13, pp. 159-160.
1912. *Enderleinellus sphærocephalus* F a h r e n h o l z, Zool. Anz., Vol. 39, p. 56.
1912. *Enderleinellus sphærocephalus* F a h r e n h o l z, 2-3-4th Jahresb. d. Niedersäch. Zool. Ver., pp. 52-53, f. 22-23; pl. 2, f. 5, 6, 7.
1916. *Enderleinellus sphærocephalus* Ferris, Psyche, Vol. 23 (in press).

5—*Enderleinellus suturalis* (Osborn). Type from *Citellus franklini* or *C. tridecemlineatus* (Iowa). Also from *C. oregonus* and *C. mollis* (Nevada, U. S. A.), *C. townsendi* (Washington, U. S. A.), *Citellus beldingi*, *Xerospermophilus tereticaudus* and *Amмосpermophilus nelsoni* (California, U. S. A.), *Cynomys gunnisoni* and *C. leucurus* (Colorado, U. S. A.).

1891. *Hæmatopinus suturalis* Osborn, Bul. 7, o. s., U. S. Dept. Agr., Div. Ent., p. 27, f. 15.
1896. *Hæmatopinus suturalis* Osborn, Bul. 5, n. s., U. S. Dept. Agr., Div. Ent., p. 185, f. 109.
1904. *Polyplax ? suturalis* Enderlein, Zool. Anz., Vol. 28, p. 143.
1908. *Polyplax ? suturalis* Dalla Torre, Gen. Ins., Anopl., p. 14.

1915. *Enderleinellus suturalis* Kellogg & Ferris, Anopl. & Mall. of N. Am. Mam., pp. 40-42; pl. 4, f. 9.
1916. *Enderleinellus suturalis* Ferris, Psyche, Vol. 23 (in press).
- 5a—*Enderleinellus suturalis* var. *occidentalis* Kellogg & Ferris. From *Callospermophilus chrysodeirus trinitatus* (California, U. S. A.).
1915. *Enderleinellus suturalis* var. *occidentalis* Kellogg & Ferris, Anopl. and Mall. of N. Am. Mam., p. 42; pl. 2, f. 3; pl. 4, f. 10; pl. 5, f. 17.
- 6—*Enderleinellus uncinatus* Ferris. From *Glaucomys sabrinus lascivus* (California, U. S. A.).
1916. *Enderleinellus uncinatus* Ferris, Psyche, Vol. 23 (in press).

Genus *Fahrenholzia* Kellogg & Ferris

Kellogg and Ferris, Anopl. and Mall. of N. Am. Mam., p. 32.

Antennæ similar in sexes. Head and thorax very small. Anterior legs small with slender claw. Middle and posterior legs much larger, sub-equal, with stout claws. Abdomen without chitinized tergal and sternal plates. Each abdominal segment with but one row of spines in both male and female. Pleural plates present on a variable number of segments. Sternite of second segment with a large chitinized plate near each lateral margin. Spiracles small.

Recorded only from *Heteromyidæ* (Rodentia).

Type of the genus *Fahrenholzia pinnata* Kellogg & Ferris.

- 1—*Fahrenholzia pinnata* Kellogg & Ferris. Type from *Dipodomys californicus* (California, U. S. A.). Also from *Dipodomys deserti*, *D. merriami*, *Perodipus* sp. and *Microdipodops polionotus* (California) and *Perognathus parvus olivaceous* (Nevada, U. S. A.).
1915. *Fahrenholzia pinnata* Kellogg & Ferris, Anopl. and Mall. of N. Am. Mam., pp. 32-35; t. f. 13; pl. 3, f. 2; pl. 5, f. 5-6; pl. 6, f. 10.
1916. *Fahrenholzia pinnata* Ferris, Psyche, Vol. 23 (in press).

2—*Fahrenholzia tribulosa* Ferris. Type from *Perognathus californicus* (California, U. S. A.). Also from *Perognathus formosus* (California).

1916. *Fahrenholzia tribulosa* Ferris, Psyche, Vol. 23 (in press).

Genus *Hæmodipsus* Enderlein

*Hæmodipsus* Enderlein, Zool. Anz., Vol. 28, pp. 139, 143 (1904); Dalla Torre, Gen. Ins., Anopl., p. 15 (1908); Mjöberg, Ark. f. Zool., Vol. 6, pt. 13, p. 165 (1910); Kellogg & Ferris, Anopl. and Mall. of N. Am. Mam., pp. 27-28 (1915).

*Hæmatopinus* (*Polyplax*) Neumann, Arch. de Par., Vol. 13, p. 536 (1909).

Anterior legs small with slender claw, middle and posterior legs larger, sub-equal, with heavier claws. Head broad, thorax very small. Abdomen entirely without chitinized tergites and sternites, each segment with a single transverse row of spines or hairs. Pleural plates very small or wanting. Gonapods very short.

Recorded only from *Leporidae* (Rodentia).

Type of the genus *Hæmodipsus lyriocephalus* (Burm.).

1—*Hæmodipsus lyriocephalus* (Burm.). Type from *Lepus timidus* (Europe). Also from *L. europæus occidentalis* (Europe).

1839. *Pediculus lyriocephalus* Burmeister, Gen. Rhyn. No. 11, f. 7.

1842. *Hæmatopinus lyriocephalus* Denny, Mon. Anopl., pp. 27-28; pl. 24, f. 4.

1864. *Pediculus lyriceps* Nitzsch, Zeits. f. ges. Naturw., Vol. 23, p. 24.

1874. *Hæmatopinus lyriocephalus* Giebel, Ins. Epizoa, pp. 39-40; pl. 2, f. 2.

1880. *Hæmatopinus lyriocephalus* Piaget, Les Ped., pp. 641-642; pl. 52, f. 5.

1904. *Hæmodipsus lyriocephalus* Enderlein, Zool. Anz., Vol. 28, p. 143.

1908. *Hæmodipsus lyriocephalus* Dalla Torre, Gen. Ins., Anopl., p. 15.

1909. *Hæmatopinus (Polyplax) lyriocephalus* Neumann, Arch. de Par., Vol. 13, p. 528.
  1910. *Hæmodipsus lyriocephalus* Mjöberg, Ark. f. Zool., Vol. 6, pt. 13, p. 165.
  1913. *Hæmodipsus lyriocephalus* Evans, Proc. Royal Phys. Soc. Edinburgh, Vol. 19, p. 94.
  1915. *Hæmodipsus lyriocephalus* Kellogg & Ferris, Anopl. & Mall. of N. Am. Mam., p. 28.
- 2—*Hæmodipsus ventricosus* (Denny). From *Oryctolagus cuniculus* (Europe). Also from "domestic rabbit" (Europe and North America), *Lepus campestris* (Iowa, U. S. A.), *Lepus californicus* (California, U. S. A.), and *L. californicus deserticola* (Arizona, U. S. A.).
1842. *Hæmatopinus ventricosus* Denny, Mon. Anopl., pp. 30-31; pl. 25, f. 6.
  1874. *Hæmatopinus ventricosus* Giebel, Ins. Epizoa, p. 47.
  1880. *Hæmatopinus ventricosus* Piaget, Les Ped., p. 642.
  1885. *Hæmatopinus ventricosus* Piaget, Les Ped., Suppl., pp. 141-147; pl. 16, f. 9.
  1896. *Hæmatopinus ventricosus* Osborn, Bul. 5, n. s., U. S. Dept. Agr., Div. Ent., p. 182.
  1904. *Hæmodipsus ventricosus* Enderlein, Zool. Anz., Vol. 28, p. 143.
  1908. *Hæmodipsus ventricosus* Dalla Torre, Gen. Ins., Anopl., p. 15.
  1909. *Hæmatopinus (Polyplax) ventricosus* Neumann, Arch. de Par., Vol. 13, pp. 527-528, f. 27.
  1910. *Hæmodipsus ventricosus* Mjöberg, Ark. f. Zool., Vol. 6, pt. 13, p. 165.
  1913. *Polyplax ventricosa* Evans, Proc. Royal Phys. Soc. Edinburgh, Vol. 19, p. 94.
  1915. *Hæmodipsus ventricosus* Kellogg & Ferris, Anopl. and Mall. of N. Am. Mam., pp. 28-30; t. f. 11; pl. 2, f. 2; pl. 4, f. 5; pl. 5, f. 12.
  1916. *Hæmodipsus ventricosus* Ferris, Psyche, Vol. 23 (in press).

Genus *Hoplopleura* Enderlein

*Hoplopleura* Enderlein, Zool. Anz., Vol. 28, pp. 221-223 (1904); Dalla Torre, Gen. Ins., Anopl., p. 14 (1908); Fahrenholz, 2-3-4th Jahresb. Niedersäch. Zool. Ver., pp. 44-46 (1912); Kellogg & Ferris, Anopl. & Mall. of N. Am. Mam., pp. 15-16 (1915).

*Hæmatopinus (Polyplax)* Neumann, Arch. de Par., Vol. 13, p. 531 (1909).

Antennæ similar in the sexes. Anterior legs small with slender claw; middle legs larger with stouter claw; posterior legs very stout with stout, heavy claw and usually with a small, pointed protuberance on the anterior margin of the tibia. Female with most of the abdominal tergites divided into three transverse plates, each bearing a row of spines. Males with most of the abdominal tergites and sternites divided into two plates or undivided, but with some divided into three. Anterior division of the third sternite in both sexes with two pairs, or with two groups of three very stout and conspicuous spines. Pleural plates present.

From *Muridæ* and *Sciuridæ* (Rodentia).

Type of the genus *Hoplopleura acanthopus* (Burm.).

1—*Hoplopleura acanthopus* (Burm.). Type from *Microtus arvalis* (Europe). Also from *Microtus agrestis*, *Mus musculus* and (?) *Sorex araneus* (Europe) and *Dicrostonyx torquatus* (Pitlekaj).

1839. *Pediculus acanthopus* Burmeister, Gen. Rhyn., No. 5, pl. 1, f. 2.

1842. *Hæmatopinus acanthopus* Denny, Mon. Anopl., p. 25; pl. 24, f. 3.

1864. *Pediculus acanthopus* Nitzsch, Zeits. f. ges. Naturw., Vol. 23, p. 27.

1874. *Hæmatopinus acanthopus* Giebel, Ins. Ep., pp. 36-37; pl. 2, f. 3.

1880. *Hæmatopinus acanthopus* Piaget, Les Ped., pp. 638-640; pl. 52, f. 4.

1904. *Polyplax acanthopus* Enderlein, Zool. Anz., Vol. 28, p. 142.

1904. *Hoplopleura acanthopus* Enderlein, Ibid., Vol. 28, pp. 220-223, f. 1-2.

1908. *Hoplopleura acanthopus* Dalla Torre, Gen. Ins., Anopl., p. 14.
1910. *Hoplopleura acanthopus* Mjöberg, Ark. f. Zool., Vol. 6, pt. 13, p. 164.
1912. *Hoplopleura acanthopus* Fahrenholz, 2-3-4th Jahresb. Niedersäch. Zool. Ver., pp. 46-52, f. 18-20; pl. 2, f. 14-15.
- 1a—*Hoplopleura acanthopus* var. *americanus* Kellogg & Ferris. Type from *Microtus californicus* (California, U. S. A.). Also from *M. (Lagurus) intermedius* and other species of *Microtus* (California, Iowa) and "white lemming" (Point Barrow, Alaska).
1891. *Hoplopleura acanthopus* Osborn, Bul. 7, o. s., U. S. Dept. Agr., Div. Ent., p. 23, f. 11.
1896. *Hoplopleura acanthopus* Osborn, Bul. 5, n. s., U. S. Dept. Agr., Div. Ent., pp. 181-182, f. 104.
1915. *Hoplopleura acanthopus* var. *americanus* Kellogg and Ferris, Anopl. and Mall. of N. Am. Mam., p. 16; t. f. 3; pl. 4, f. 2; pl. 5, f. 8.
- 2—*Hoplopleura arboricola* Kellogg & Ferris. Type from *Eutamias sonomæ* (California, U. S. A.). Also from *Sciurus griseus griseus*, *S. douglasi mollipilosus*, *S. douglasi albolimbatus*, *Eutamias alpinus*, *E. hindsi*, *E. sonomæ*, *E. merriami pricci*, *E. townsendi ochrogenys*, *E. speciosus frater* (California), and *Tamias striatus* (Iowa, U. S. A.).
1915. *Hoplopleura arboricola* Kellogg & Ferris, Anopl. and Mall. of N. Am. Mam., pp. 19-21; t. f. 6-7; pl. 4, f. 4; pl. 6, f. 8.
1916. *Hoplopleura arboricola* Ferris, Psyche, Vol. 23 (in press).
- 3—*Hoplopleura bidentata* (Neumann). From *Epimys rattus* (Lake Torrens, Australia).
1909. *Hæmatopinus (Polyplax) bidentatus* Neumann, Arch. de Par., Vol. 13, pp. 515-517, f. 18.
1915. *Hoplopleura* ? *bidentata* Kellogg & Ferris, Ann. Durban Mus., Vol. 1, pt. 2, p. 155.
- 4—*Hoplopleura enormis* Kellogg & Ferris. From *Arvicanthis dorsalis* (S. Africa).

1915. *Hoplopleura enormis* Kellogg & Ferris, Ann. Durban. Mus., Vol. 1, pt. 2, pp. 155-157; pl. 16, f. 4-4e.
- 5—*Hoplopleura erratica* (Osborn). Type from *Larus bonapartii* (straggler). Also from *Glaucomys volans*, *Microtus pennsylvanicus* and *Tamias striatus* (North America).
1896. *Hæmatopinus erraticus* Osborn, Bul. 5, n. s., U. S. Dept. Agr., Div. Ent., p. 186.
1904. *Polyplax* ? *erraticus* Enderlein, Zool. Anz., Vol. 28, p. 143.
1908. *Polyplax* ? *erratica* Dalla Torre, Gen. Ins., Anopl., p. 13.
1915. *Hoplopleura* ? *erratica* Kellogg & Ferris, Anopl. and Mall. of N. Am. Mam., pp. 18-19.
- NOTE: One of the three species, *Hoplopleura arboricola* Kellogg & Ferris, *H. trispinosa* Kellogg & Ferris, or *H. acanthopus* var. *americanus* Kellogg & Ferris, is probably a synonym of this species.
- 6—*Hoplopleura hesperomydis* (Osborn). Type from *Peromyscus leucopus* (Iowa, U. S. A.). Also from *Peromyscus maniculatus rubidus*, *P. maniculatus gambeli*, *P. boylei* and *Mus musculus* (California, U. S. A.).
1891. *Hæmatopinus hesperomydis* Osborn, Bul. 7, o. s., U. S. Dept. Agr., Div. Ent., p. 26, f. 14.
1896. *Hæmatopinus hesperomydis* Osborn, Bul. 5, n. s., U. S. Dept. Agr., Div. Ent., pp. 184-185, f. 108.
1904. *Polyplax* ? *hesperomydis* Enderlein, Zool. Anz., Vol. 28, p. 143.
1908. *Polyplax* ? *hesperomydis* Dalla Torre, Gen., Anopl., p. 13.
1915. *Hoplopleura hesperomydis* Kellogg & Ferris, Anopl. and Mall. of N. Am. Mam., p. 17; t. f. 4-5; pl. 4, f. 1; pl. 5, f. 14.
- 7—*Hoplopleura hirsuta* Ferris. Type from *Sigmodon hispidus* (North Carolina, U. S. A.). Also from *Sigmodon hispidus texianus* (Texas, U. S. A.) and *S. hispidus eremicus* (California, U. S. A.).
1916. *Hoplopleura hirsuta* Ferris, Psyche, Vol. 23 (in press).

8—*Hoplopleura hispida* (Grube). From *Lemmus obensis* (Siberia).

1851. *Pediculus hispidus* Grube, Midd. Reise, Zool., p. 497; pl. 32, f. 2 (figure labeled *P. gracilis*).  
1874. *Hæmatopinus hispidus* Giebel, Ins. Ep., p. 38.  
1880. *Hæmatopinus hispidus* Piaget, Les Ped., p. 640.  
1904. *Polyplax hispida* Enderlein, Zool. Anz., Vol. 28, p. 142.  
1908. *Polyplax hispida* Dalla Torre, Gen. Ins., Anopl., p. 13.

NOTE: This is probably a synonym of *H. acanthopus* (Burm.).

9—*Hoplopleura intermedia* Kellogg & Ferris. Type from *Mus coucha* (Zululand, South Africa).

1915. *Hoplopleura intermedia* Kellogg & Ferris, Ann. Durban Mus., Vol. 1, pt. 2, pp. 153-154; pl. 16, f. 5-5d.  
1916. *Hoplopleura intermedia* Ferris, ibid., Vol. 23 (in press).

10—*Hoplopleura longula* (Neumann). From *Micromys minutus* (Europe).

1909. *Hæmatopinus* (*Polyplax*) *longulus* Neumann, Arch. de Par., Vol. 13, pp. 513-515, f. 15-17.  
1910. *Hoplopleura lincata* Fahrenholz, Zool. Anz., Vol. 35, p. 715, fig.  
1915. *Hoplopleura* ? *longula* Kellogg & Ferris, Ann. Durban Mus., Vol. 1, pt. 2, p. 155.

11—*Hoplopleura maniculata* (Neumann). From *Sciurus palmarum* (Asia).

1909. *Hæmatopinus* (*Polyplax*) *maniculatus* Neumann, Arch. de Par., Vol. 13, pp. 521-523, f. 21-22.  
1915. *Hoplopleura* ? *maniculata* Kellogg & Ferris, Ann. Durban Mus., Vol. 1, pt. 2, p. 155.

12—*Hoplopleura quadridentata* (Neumann). Type from *Holochilus squamipes* (probably *Nectomys squamipes* or *Nectomys apicalis*) (Peru, South America). Also from *Nesoryzomys indefessus* and *N. narboroughi* (Galapagos Islands, South America).

1909. *Hæmatopinus (Polyplax) quadridentatus* Neumann, Arch. de Par., Vol. 13, pp. 513-515.
1915. *Hoplopleura* ? *quadridentata* Kellogg & Ferris, Ann. Durban Mus., Vol. 1, pt. 2, p. 155.
1916. *Hoplopleura quadridentata* Ferris, Psyche, Vol. 23 (in press).
- 13—*Hoplopleura trispinosa* Kellogg & Ferris. Type from *Glaucomys sabrinus* ssp. ? (Oregon, U. S. A.). Also from *Glaucomys sabrinus lascivus* (California, U. S. A.) and *G. volans* (Maryland, U. S. A.).
1915. *Hoplopleura trispinosa* Kellogg & Ferris, Anopl. and Mall. of N. Am. Mam., pp. 22-23, t. f. 8; pl. 4, f. 3.
1916. *Hoplopleura trispinosa* Ferris, Psyche, Vol. 23 (in press).

Genus *Hybophthirus* Enderlein

Enderlein, Denksch. d. Med.-Naturw. Gesell. zu Jena, Vol. 14, p. 79 (1909); Cummings, Bul. Ent. Res., Vol. 4, p. 44 (1913).

Tarsus of anterior legs two-segmented, of the remainder one-segmented. Anterior legs small and slender, middle and posterior legs large and stout. Abdomen without strongly chitinated tergites and sternites. Pleural plates present. Thorax with a flattened triangular process on the dorsum near each lateral margin.

Recorded only from Orycteropodidæ (Tubulidentata).

Type of the genus *Hybophthirus notophallus* (Neumann).

- 1—*Hybophthirus notophallus* (Neumann). From *Orcyteropus afer* (South Africa, German East Africa).

1909. *Hæmatopinus notophallus* Neumann, Jahrb. des Nassausischen Ver. f. Naturkunde, in Wiesbaden, p. 2.

1909. *Hybophthirus orycteropodi* Enderlein, Denksch. des Med.-Naturw. Gesell. zu Jena, Vol. 14, pp. 79-80; pl. 8, f. 1-3.

1913. *Hybophthirus notophallus* Cummings, Bul. Ent. Res., Vol. 4, pp. 44-45.

1914. *Hybophthirus notophallus* Waterston, Ann. S. Af. Mus., Vol. 10, pt. 9, p. 278.

Genus *Linognathoides* Cummings

Cummings, Bul. Ent. Res., Vol. 5, pp. 159-160 (1914); Kellogg & Ferris, Anopl. & Mall. of N. Am. Mam., pp. 23-24 (1915).

In general similar to *Polyplax*. Abdomen without chitinated tergal and sternal plates or with these very much reduced. Pleural plates present. Spiracles small.

Recorded from Muridæ and Sciuridæ (Rodentia).

Type of the genus *Linognathoides citelli* Cummings.

1—*Linognathoides citelli* Cummings. From *Citellus leptodactylus* and ? *Cricetulus phæus* (Transcaspia).

1914. *Linognathoides spermophili* Cummings, Bul. Ent. Res., Vol. 5, pp. 160-163, t. f. 3.

1916. *Linognathoides citelli* Cummings, Ann. Mag. Nat. Hist., ser. 8, Vol. 17, p. 107.

2—*Linognathoides inornatus* Kellogg & Ferris. Type from *Neotoma cinerea occidentalis* (California, U. S. A.). Also from *N. cinerea cinerea* and ? *N. fuscipes streator* (California).

1915. *Linognathoides inornatus* Kellogg & Ferris, Anopl. & Mall. of Am. Mam., pp. 25-27, t. f. 10; pl. 2, f. 1; pl. 4, f. 7; pl. 5, f. 15; pl. 6, f. 3.

1916. *Linognathoides inornatus* Ferris, Psyche, Vol. 23 (in press).

3—*Linognathoides læviusculus* (Grube). Type from *Citellus evermanni* (Jakutsk, Siberia).

1851. *Pediculus læviusculus* Grube, Middendorff's Reise, Vol. 2, p. 498; pl. 32, f. 5 (figure labeled *P. spermophili*).

1874. *Hæmatopinus læviusculus* Giebel, Ins. Epizoa, p. 38.

1880. *Hæmatopinus læviusculus* Piaget, Les Ped., p. 641.

1904. *Polyplax læviusculus* Enderlein, Zool. Anz., Vol. 28, p. 142.

1908. *Polyplax læviusculus* Dalla Torre, Gen. Ins., Anopl., p. 13.

1910. *Polyplax læviuscula* Mjöberg, Ark. f. Zool., Vol. 6. pt. 13, p. 160.

- 4—*Linognathoides montanus* (Osborn). Type from "Western Gray Squirrel" (probably *Citellus* sp.) (Ft. Collins, Colorado, U. S. A.). Also from *Citellus barrowensis* ? (Pt. Barrow, Alaska), *Citellus beccheyi*, *C. douglasi* (California, U. S. A.), *C. columbianus* (Washington, U. S. A.), *C. grammurus* (Arizona, U. S. A.), *C. mexicanus* ? (Guanajuato, Mexico), *Marmota flaviventris sierræ* (California, U. S. A.) and "Rock Squirrel" (Boulder, Colorado, U. S. A.).
1896. *Hæmatopinus montanus* Osborn, Bul. 5, n. s., U. S. Dept. Agr., Div. Ent., p. 184, f. 107.
1900. *Hæmatopinus columbianus* Osborn, Can. Ent., Vol. 32, pp. 215-216.
1904. *Polyplax* ? *montana* Enderlein, Zool. Anz., Vol. 28, p. 143.
1904. *Polyplax* ? *columbiana* Enderlein, Ibid., p. 143.
1908. *Polyplax* ? *columbiana* Dalla Torre, Gen. Ins., Anopl., p. 13.
1908. *Polyplax* ? *montana* Dalla Torre, Ibid., p. 13.
1914. *Linognathoides* ? *columbianus* Cummings, Bul. Ent. Res., Vol. 5, p. 160.
1915. *Linognathoides montanus* Kellogg & Ferris, Anopl. and Mall. of N. Am. Mam., pp. 24-25; t. f. 9; pl. 5, f. 1; pl. 6, f. 4.
1916. *Linognathoides montanus* Ferris, Psyche, Vol. 23 (in press).
- 5—*Linognathoides pectinifer* (Neumann). From *Xerus getulus* (Northern Africa).
1885. *Hæmatopinus setosus* (not of Burmeister) Piaget, Les Ped., Suppl., p. 143; pl. 15, f. 6.
1908. *Hæmatopinus setosus* Dalla Torre, Gen. Ins., Anopl., p. 11.
1909. *Hæmatopinus* (*Polyplax*) *pectinifer* Neumann, Arch. de Par., Vol. 13, pp. 528-529, f. 28-29.
1914. *Linognathoides setosus* Cummings, Bul. Ent. Res., Vol. 5, p. 160.

Genus *Linognathus* Enderlein

*Trichaulus* Enderlein, Zool. Anz., Vol. 28, pp. 139, 141 (1904).

*Linognathus* Enderlein, Ibid., Vol. 29, p. 194 (1905); Dalla Torre, Gen. Ins., Anopl., p. 12 (1908); Mjöberg, Ark. f. Zool., Vol. 6, pt. 13, p. 156 (1910); Kellogg & Ferris, Anopl. & Mall. of N. Am. Mam., p. 10 (1915).

*Solenopotes* Enderlein, Zool. Anz., Vol. 28, p. 143 (1904); Dalla Torre, Gen. Ins., Anopl., p. 15 (1908).

*Hæmatopinus* (*Linognathus*) Neumann, Arch. de Par., Vol. 13, pp. 529-530 (1909).

Head usually rather slender and elongated. Temporal angles not prominent. Middle and posterior legs nearly equal in size, larger and stouter than the anterior. Abdomen entirely without chitinized tergal, sternal and pleural plates. Each abdominal segment with two or three transverse rows of hairs. Spiracles large. Gonapods usually long.

From *Perissodactyla*, *Artiodactyla*, *Hyracoidea*, and from the domestic dog.

Type of the genus *Linognathus piliferus* (Burm.).

- 1—*Linognathus angulatus* (Piaget). Type from *Cephalophus nigrifrons* (Africa). Also from *Cephalophus natalensis* and *Cephalophus* sp. (Africa).

1885. *Hæmatopinus unguatus* Piaget, Les Ped., Suppl., p. 144; pl. 15, f. 7.

NOTE: *ungulatus* is evidently a misprint for *angulatus*, the latter appearing in the description of the plates.

1908. *Hæmatopinus unguatus* Dalla Torre, Gen. Ins., Anopl., p. 11.

1910. *Linognathus angulatus* Mjöberg, Ark. f. Zool., p. 157.

1916. *Linognathus angulatus* Ferris, Ann. Durban Mus., Vol. 2 (in press).

- 2—*Linognathus breviceps* (Piaget). Type from *Cephalophus maxwelli* (Africa). Also from ? "Cearrus-Hirsch" (Guatemala).

1885. *Hæmatopinus breviceps* Piaget, Les Ped., Suppl., p. 142; pl. 15, f. 5.

1908. *Hæmatopinus breviceps* Dalla Torre, Gen. Ins., Anopl., p. 11.

NOTE: This species is probably the young of *Linognathus angulatus* (Piaget).

- 3—*Linognathus brevicornis* (Giebel). From *Giraffa camelopardalis* (Africa).  
1874. *Hæmatopinus brevicornis* Giebel, Ins. Epizoa, pp. 43-44.  
1880. *Hæmatopinus brevicornis* Piaget, Les Ped., pp. 644-646; pl. 52, f. 7.  
1904. *Trichaulus brevicornis* Enderlein, Zool. Anz., Vol. 28, p. 142.  
1905. *Linognathus brevicornis* Enderlein, Ibid., Vol. 29, p. 194.  
1908. *Linognathus brevicornis* Dalla Torre, Gen. Ins., Anopl., p. 12.
- 4—*Linognathus caviæ-capensis* (Pallas). From *Procavia capensis* (South Africa).  
1767. *Pediculus caviæ-capensis* Pallas, Spicilegia Zoologica, Vol. 12, p. 32; pl. 3, f. 12-13.  
1874. *Hæmatopinus leptoccephalus* Giebel, Ins. Epizoa, p. 47.  
1880. *Hæmatopinus leptoccephalus* Piaget, Les Ped., p. 656.  
1904. *Hæmatopinus leptoccephalus* Enderlein, Zool. Anz., Vol. 28, p. 141.  
1908. *Hæmatopinus leptoccephalus* Dalla Torre, Gen. Ins., Anopl., p. 11.  
1913. *Linognathus caviæ-capensis* Cummings, Bul. Ent. Res., Vol. 4, pp. 37-39, f. 2-3.
- 5—*Linognathus fahrenheitsi* Paine. Type from *Cervicapra arundinum* (Nyasaland, Africa). Also from *Cervicapra fulvorufula* (Zululand, Africa).  
1911. *Linognathus forficulus* (not of Rudow) Kellogg & Paine, Bul. Ent. Res., Vol. 2, p. 147; pl. 4, f. 2-4.  
1914. *Linognathus fahrenheitsi* Paine, Psyche, Vol. 21, p. 117.  
1916. *Linognathus fahrenheitsi* Ferris, Ann. Durban Mus., Vol. 2 (in press).
- 6—*Linognathus forficulus* (Rudow). From *Capra ibex* (Europe).  
1869. *Hæmatopinus forficulus* Rudow, Zeit. f. ges. Naturw., Vol. 34, p. 169.

1874. *Hæmatopinus forficulus* Giebel, Ins. Epizoa, p. 47.
1908. *Hæmatopinus?* *forficulus* Dalla Torre, Gen. Ins., Anopl., p. 11.
1914. *Linognathus forficulus* Paine, Psyche, Vol. 21, p. 117.
- 7—*Linognathus gazella* Mjöberg. From "gazelle." (Zool. Mus. Hamburg).
1910. *Linognathus gazella* Mjöberg, Ark. f. Zool., Vol. 6, pt. 13, pp. 157-159, f. 78.
- 8—*Linognathus leptocephalus* (Ehrenberg). From *Procapra syriacus* (Syria).
1829. *Pediculus leptocephalus* Ehrenberg, Symbolæ Physicæ.
1874. *Hæmatopinus leptocephalus* Giebel, Ins. Epizoa, p. 47.
1880. *Hæmatopinus leptocephalus* Piaget, Les Ped., p. 656.
1904. *Hæmatopinus leptocephalus* Enderlein, Zool. Anz., Vol. 28, p. 141.
1908. *Hæmatopinus leptocephalus* Dalla Torre, Gen. Ins., Anopl., p. 11.
1913. *Linognathus leptocephalus* Cummings, Bul. Ent. Res., Vol. 4, p. 37.
- 9—*Linognathus limnotragi* Cummings. From *Limnotragus gratus* (Congo, Africa).
1913. *Linognathus limnotragi* Cummings, Bul. Ent. Res., Vol. 4, pp. 36-37, f. 1.
- 10—*Linognathus ovillus* (Neumann). From domestic sheep (Scotland and New Zealand).
1907. *Hæmatopinus ovillus* Neumann, Revue vétérinaire, pp. 520-524.
1913. *Linognathus ovillus* Evans, Proc. Royal Phys. Soc. Edinburgh, Vol. 19, p. 94.
- 11—*Linognathus pedalis* (Osborn). From domestic sheep (Minnesota, Iowa and Nevada, U. S. A.).
1896. *Hæmatopinus pedalis* Osborn, Bul. 5, n. s., U. S. Dept. Agr., Div. Ent., pp. 170-172, f. 99.

1896. *Hæmatopinus ovis* Lugger, Rept. Ent., State Exper. Station, Minnesota, pp. 105-106, f. 75-76.
1904. *Trichaulus pedalis* Enderlein, Zool. Anz., Vol. 28, p. 142.
1905. *Linognathus pedalis* Enderlein, Zool. Anz., Vol. 29, p. 194.
1908. *Linognathus pedalis* Dalla Torre, Gen. Ins., Anopl., p. 12.
1915. *Linognathus pedalis* Kellogg & Ferris, Anopl. & Mall. of N. Am. Mam., p. 11.
- 12—*Linognathus piliferus* (Burmeister). From domestic dog (Cosmopolitan). Also once recorded from a ferret (England).
1776. *?Pediculus canis familiaris* Müller, Prodr. Faunæ Daniæ, p. 184.
1780. *?Pediculus canis familiaris* Fabricius, Fauna Gröenland, p. 215.
1838. *Pediculus piliferus* Burmeister, Gen. Rhyn., No. 13.
1842. *Hæmatopinus piliferus* Denny, Mon. Anopl., pp. 28-29; pl. 25, f. 4.
1847. *Hæmatopinus bicolor* Lucas, Ann. Soc. Ent. France, Vol. 5, ser. 2, pp. 538-539; pl. 8, f. 2a.
1861. *Pediculus isopus* Nitzsch, Zeit. f. ges. Naturw., Vol. 18, p. 290.
1864. *Pediculus flavidus* Nitzsch, Ibid., Vol. 23, p. 27.
1874. *Hæmatopinus piliferus* Giebel, Ins. Epizoa, pp. 40-41.
1880. *Hæmatopinus piliferus* Piaget, Les Ped., pp. 643-644; pl. 52, f. 6.
1891. *Hæmatopinus piliferus* Osborn, Bul. 7, o. s., U. S. Dept. Agr., Div. Ent., pp. 11-12, f. 5.
1896. *Hæmatopinus piliferus* Osborn, Bul. 5, n. s., U. S. Dept. Agr., Div. Ent., p. 169, f. 98.
1904. *Trichaulus piliferus* Enderlein, Zool. Anz., Vol. 28, p. 142.
1905. *Linognathus piliferus* Enderlein, Ibid., Vol. 29, p. 194.

1908. *Linognathus piliferus* Dalla Torre, Gen. Ins., Anopl., p. 12.
1910. *Linognathus piliferus* Mjöberg, Ark. f. Zool., Vol. 6, pt. 13, p. 157, t. 77.
1915. *Linognathus piliferus* Kellogg & Ferris, Anopl. & Mall. of N. Am. Mam., p. 11.
- 13—*Linognathus prælongiceps* (Neumann). From *Auchenia huanaca* (Bolivia, S. America).
1909. *Hæmatopinus (Linognathus) prælongiceps* Neumann, Arch. de Par., Vol. 13, pp. 508-511, f. 10-12.
- 14—*Linognathus stenopsis* (Burmeister). Type from domestic goat (Europe). Also from domestic goat (California, U. S. A.), sheep (Africa), *Antilope rupicapra* and *Capra ægyptica*.
1838. *Pediculus stenopsis* Burmeister, Gen. Rhyn., No. 3.
1842. *Hæmatopinus stenopsis* Denny, Mon. Anopl., p. 36.
1847. *Pediculus saccatus* Gervais, Apteres, Vol. 3, p. 307.
1864. *Pediculus stenopsis* Nitzsch, Zeit. f. ges. Naturw., Vol. 23, p. 30.
1864. *Pediculus schistopygus* Nitzsch, Ibid., Vol. 23, p. 31.
1874. *Hæmatopinus saccatus* Giebel, Ins. Epizoa, p. 47.
1874. *Hæmatopinus stenopsis* Giebel, Ibid., p. 44; pl. 2., f. 4.
1880. *Hæmatopinus saccatus* Piaget, Les Ped., p. 648.
1880. *Hæmatopinus stenopsis* Piaget, Ibid., p. 648.
1891. *Hæmatopinus stenopsis* Osborn, Bul. 7, o. s., U. S. Dept. Agr., Div. Ent., p. 12.
1896. *Hæmatopinus stenopsis* Osborn, Bul. 5, n. s., U. S. Dept. Agr., Div. Ent., p. 170.
1904. *Trichaulus saccatus* Enderlein, Zool. Anz., Vol. 28, p. 142.
1904. *Trichaulus stenopsis* Enderlein, Ibid., Vol. 28, p. 142.

- 1905. *Linognathus saccatus* Enderlein, Ibid., Vol. 29, p. 194.
- 1905. *Linognathus stenopsis* Ibid., Vol. 29, p. 194.
- 1908. *Linognathus saccatus* Dalla Torre, Gen. Ins., Anopl., p. 12.
- 1908. *Linognathus stenopsis* Dalla Torre, Ibid., p. 12.
- 1910. *Linognathus stenopsis* Mjöberg, Ark. f. Zool., Vol. 6, pt. 13, p. 159.
- 1911. *Linognathus africanus* Kellogg & Paine, Bul. Ent. Res., Vol. 2, p. 146; pl. 4, f. 1, 5.
- 1915. *Linognathus stenopsis* Kellogg & Ferris, Anopl. & Mall. of N. Am. Mam., p. 11.

NOTE: *Linognathus saccatus* is an unrecognizable species, recorded from *Capra ægyptica* (equals *Capra ægagrus* ?), but it is very probably the same as *Linognathus stenopsis*.

15—*Linognathus rupicaprae* (Rudow). From *Rupicapra rupicapra* (Europe).

- 1869. *Hæmatopinus rupicaprae* Rudow, Zeit. f. ges. Naturw., Vol. 34, p. 170.
- 1874. *Hæmatopinus rupicaprae* Giebel, Ins. Epizoa, p. 47.
- 1880. *Hæmatopinus rupicaprae* Piaget, Les Ped., p. 648.
- 1908. *Hæmatopinus rupicaprae* Dalla Torre, Gen. Ins., Anopl., p. 11.

16—*Linognathus tibialis* (Piaget). From *Antilope maori* (Zool. Garden, Rotterdam).

- 1880. *Hæmatopinus tibialis* Piaget, Les Ped., pp. 646-647; pl. 52, f. 8.
- 1904. *Trichaulus tibialis* Enderlein, Zool. Anz., Vol. 28, p. 142.
- 1905. *Linognathus tibialis* Enderlein, Ibid., Vol. 29, p. 194.
- 1908. *Linognathus tibialis* Dalla Torre, Gen. Ins., Anopl., p. 12.

16a—*Linognathus tibialis* var. *antennatus* (Piaget). From *Antilope* sp. (Zool. Garden, Rotterdam).

- 1880. *Hæmatopinus tibialis* var. *antennatus* Piaget, Les Ped., p. 647; pl. 52, f. 8e.

1908. *Linognathus tibialis* var. *antennatus* Dalla Torre, Gen. Ins., Anopl., p. 12.
- 16b—*Linognathus tibialis* var. *appendiculatus* (Piaget). From *Antilope subgutturosa* (= *Gazella subgutturosa*?) (Zool. Garden, Rotterdam).
1880. *Hæmatopinus tibialis* var. *appendiculatus* Piaget, Les Ped., p. 647; pl. 52, f. 8g.
1908. *Linognathus tibialis* var. *appendiculatus* Dalla Torre, Gen. Ins., Anopl., p. 12.
- 16c—*Linognathus tibialis* var. *cervicapra* (Lucas). From *Antilope cervicapra* (India).
1847. *Hæmatopinus cervicapra* Lucas, Ann. Ent. Soc. France, Vol. 5, ser. 2, p. 534; pl. 7, f. 1.
1880. *Hæmatopinus tibialis* var. *cervicapra* Piaget, Les Ped., p. 647.
1908. *Linognathus tibialis* var. *cervicapra* Dalla Torre, Gen. Ins., Anopl., p. 13.
- 16d—*Linognathus tibialis* var. *euchore* Waterston. From *Antilope euchore* (Africa).
1914. *Linognathus tibialis* var. *euchore* Waterston, Ann. S. African Mus., Vol. 10, pt. 9, pp. 275-278, f. 1.
- 17—*Linognathus vituli* (Linnæus). From domestic cattle. (Cosmopolitan).
1758. *Pediculus vituli* Linnæus, Systema Naturæ, ed. 10, p. 611.
1766. *Pediculus vituli* Linnæus, Systema Naturæ, ed. 12, p. 1018.
1829. *Hæmatopinus vituli* Stephens, Catalogue, Vol. 2, p. 329.
1838. *Pediculus tenuirostris* Burmeister, Gen. Rhyn., No. 17.
1842. *Hæmatopinus vituli* Denny, Mon. Anopl., pp. 31-32; pl. 25, f. 3.
1864. *Pediculus oxyrrhynchus* Nitzsch, Zeit. f. ges. Naturw., Vol. 23, p. 21.
1874. *Hæmatopinus tenuirostris* Giebel, Ins. Epizoa, p. 43; pl. 2, f. 9.
1880. *Hæmatopinus tenuirostris* Piaget, Les Ped., p. 650.

- 1883. *Hæmatopinus tenuirostris* Strobelet, Ann. Mag. Nat. Hist., Vol. 11, ser. 5, pp. 73-108; pl. 3.
- 1885. *Hæmatopinus tenuirostris* Piaget, Les Ped., Suppl., pp. 145-146; pl. 15, f. 8.
- 1891. *Hæmatopinus vituli* Osborn, Bul. 7, o. s., U. S. Dept. Agr., Div. Ent., pp. 16-18, f. 7.
- 1896. *Hæmatopinus vituli* Osborn, Bul. 5, n. s., U. S. Dept. Agr., Div. Ent., pp. 176-177, f. 101.
- 1904. *Trichaulus vituli* Enderlein, Zool. Anz., Vol. 28, p. 142.
- 1904. *Solenopotes capillatus* Enderlein, Zool. Anz., Vol. 28, p. 144, f. 14,15.
- 1908. *Linognathus vituli* Dalla Torre, Gen. Ins., Anopl., p. 12.
- 1908. *Solenopotes capillatus* Dalla Torre, Ibid., p. 15.
- 1915. *Linognathus vituli* Kellogg & Ferris, Anopl. & Mall. of N. Am. Mam., p. 10.
- 1916. *Linognathus vituli* Ferris, Ent. News, Vol. 27 (in press).

Genus *Cervophthirius* Mjöberg

*Cervophthirius* Mjöberg, Ent. Tidskrift, Vol. 36, p. 282 (1915); Ferris, Ent. News, Vol. 27 (in press), 1916.

Differing from *Linognathus* only in the sharp posterior lateral angles of the head and the presence of but a single row of hairs upon each abdominal segment.

Recorded only from Cervidæ (Artiodactyla).

Type of the genus *Cervophthirius tarandi* Mjöberg.

- 1—*Cervophthirius crassicornis* (Nitzsch). Type from *Cervus claphus* (Europe). Also from *Odocoileus columbianus* (California, U. S. A.).

- 1818. *Pediculus crassicornis* Nitzsch, Germar's Mag., Vol. 3, p. 305.
- 1842. *Hæmatopinus crassicornis* Denny, Mon. Anopl., p. 36.
- 1864. *Pediculus crassicornis* Nitzsch, Zeit. f. ges. Naturw., Vol. 23, p. 26.
- 1874. *Hæmatopinus crassicornis* Giebel, Ins. Epizoa, p. 41; pl. 2, f. 7.

1880. *Hamatopinus crassicornis* Piaget, Les Ped., p. 644.
1908. *Hamatopinus crassicornis* Dalla Torre, Gen. Ins., Anopl., p. 11.
1916. *Cervophthirius crassicornis* Ferris, Ent. News, Vol. 27 (in press).
- 2—*Cervophthirius tarandi* Mjöberg. From *Rangifer tarandus* (Karesuando, Sweden).
1915. *Cervophthirius tarandi* Mjöberg, Ent. Tidskrift, Vol. 36, pp. 283-285, f. 1-4.
- NOTE: It is extremely doubtful if this is at all distinct from *Cervophthirius crassicornis* (N.).

Genus *Eulinognathus* Cummings

*Eulinognathus* Cummings, Ann. Mag. Nat. Hist., ser. 8, Vol. 17, p. 90 (1916).

Head longer than broad, antennæ arising just in front of half way, broader behind the antennæ than in front. Behind, the head is sunk deep into the thorax. Around the mouth, in front, a circlet of triangular denticles. Abdomen without tergites or sternites. Five pairs of pleurites, the anterior pair well developed. First pair of legs small, second and third larger, sub-equal. Hairs on the abdomen modified, long, flattened, parallel-sided, truncate at tip, one row on each segment.

Type of the genus *Eulinognathus denticulatus* Cummings.  
Recorded from *Pedetidae* and *Dipodidae* (Rodentia).

- 1—*Eulinognathus denticulatus* Cummings. From *Pedetes caffer*.
1916. *Eulinognathus denticulatus* Cummings, Ann. Mag. Nat. Hist., ser. 8, Vol. 17, pp. 90-94, f. 1.
- 2—*Eulinognathus aculeatus* (Neumann). From *Dipus* sp. (Djerba, Tunis).
1912. *Hamatopinus (Polyplax) aculeatus* Neumann, Bul. Soc. Zool., France, Vol. 37, pp. 143-145, f. 5-6.

Genus *Ncohamatopinus* Mjöberg

*Ncohamatopinus* Mjöberg, Ark. f. Zool., Vol. 6, pt. 13, p. 160 (1910); Cummings, Bul. Ent. Res., Vol. 3, p. 393

(1912); Kellogg & Ferris, Anopl. and Mall. of N. Am. Mam., pp. 35-36.

*Acanthopinus* Mjöberg, Ark. f. Zool., Vol. 6, pt. 13, pp. 160-161 (1910).

Antennæ dissimilar in the sexes, the male with a preaxial process or a pair of spines at the apex of the third antennal segment. First antennal segment in both sexes usually with the distal post axial angle more or less produced and bearing a stout spine or with a stout spine on the posterior margin. Anterior legs small, with slender claw, middle and posterior legs larger. Abdomen with or without chitinated tergal and sternal plates. Abdominal tergites and sternites of the female, for the most part, with two transverse rows of spines, male with lesser number, bearing two rows of spines. Posterior margin of second tergite of male always distinctly emarginate with a closely set group of spines of various lengths at the end of this emargination. Pleural plates present. Spiracles small. Gonapods very short.

Recorded from *Sciuridæ* and *Petauristidæ* (Rodentia).

Type of the genus *Neohæmatopinus sciuropteri* (Osborn).

- 1—*Neohæmatopinus antennatus* (Osborn). Type from *Sciurus cinereus* var. *ludovicianus* (probably *S. niger rufiventer*), (Iowa, U. S. A.). Also from *Sciurus griseus griseus* (California, U. S. A.).

- 1891. *Hæmatopinus antennatus* Osborn, Bul. 7, o. s., U. S. Dept. Agr., Div. Ent., p. 25, f. 13.
- 1896. *Hæmatopinus antennatus* Osborn, Bul. 5, n. s., U. S. Dept. Agr., Div. Ent., pp. 183-184, f. 106.
- 1904. *Polyplax? antennata* Enderlein, Zool. Anz., Vol. 28, p. 143.
- 1908. *Polyplax? antennata* Dalla Torre, Gen. Ins., Anopl., p. 13.
- 1910. *Acanthopinus antennatus* Mjöberg, Ark. f. Zool., Vol. 6, pt. 13, p. 161.
- 1915. *Neohæmatopinus antennatus* Kellogg & Ferris, Anopl. & Mall. of N. Am. Mam., pp. 36-37; t. f. 14a-14b; pl. 5, f. 10; pl. 6, f. 5.

- 1a—*Neohæmatopinus antennatus* var. *semifasciatus* Ferris. Type from *Sciurus douglasi albolimbatus* (California, U. S. A.). Also from *S. douglasi mollipilosus* (California).

1915. *Neohæmatopinus antennatus* (in part) Kellogg & Ferris, Anopl. & Mall. of N. Am. Mam., pp. 36-37.
1916. *Neohæmatopinus antennatus* var. *semifasciatus* Ferris, Psyche, Vol. 23 (in press).
- NOTE: This is perhaps identical with *Neohæmatopinus sciurinus* (Mjöb.).
- 2—*Neohæmatopinus echinatus* (Neumann). From *Sciurus palmarum* (Asia). Also as straggler or mistaken record from a bat, *Scotophilus wroughtoni* (Asia).
1909. *Hæmatopinus (Polyplax) echinatus* Neumann, Arch. de Par., Vol. 13, pp. 517-521, f. 19-20.
1912. *Neohæmatopinus echinatus* Cummings, Bul. Ent. Res., Vol. 3, p. 393.
- 3—*Neohæmatopinus heliosciuri* Cummings. From *Heliosciurus palliatus* (British East Africa).
1912. *Neohæmatopinus helioscui* Cummings, Bul. Ent. Res., Vol. 3, pp. 393-395, f. 1.
- 4—*Neohæmatopinus pacificus* Kellogg & Ferris. Type from *Eutamias sonomæ* (California, U. S. A.). Also from *Eutamias hindsi*, *E. alpinus* and other species of *Eutamias*. (California).
1915. *Neohæmatopinus pacificus* Kellogg & Ferris, Anopl. and Mall. of N. Am. Mam., pp. 38-40; t. f. 14c-14d; pl. 1, f. 2; pl. 5, f. 3, 7a-7b.
1916. *Neohæmatopinus pacificus* Ferris, Psyche, Vol. 23 (in press).
- 5—*Neohæmatopinus sciurinus* (Mjöberg). From *Sciurus vulpinus* (Zool. Mus. Hamburg). (This is perhaps *Sciurus niger* of North America).
1910. *Acanthopinus sciurinus* Mjöberg, Ark. f. Zool., Vol. 6, pt. 13, pp. 161-164, f. 80-83.
1912. *Neohæmatopinus sciurinus* Cummings, Bul. Ent. Res., Vol. 3, p. 393.
- 6—*Neohæmatopinus sciuropteri* (Osborn). Type from *Glaucomyz volans* (Iowa, U. S. A.). Also from *Glaucomyz sabrinus lascivus* and *G. sabrinus ssp.* (California, U. S. A.).
1891. *Hæmatopinus sciuropteri* Osborn, Bul. 7, o. s., U. S. Dept. Agr., Div. Ent., pp. 23-24, f. 12.

1896. *Hæmatopinus sciuropteri* Osborn, Bul. 5, n. s., U. S. Dept. Agr., Div. Ent., pp. 182-183, f. 105.  
1904. *Polyplax* ? *sciuropteri* Enderlein, Zool. Anz., Vol. 28, p. 143.  
1908. *Polyplax* ? *sciuropteri* Dalla Torre, Gen. Ins., Anopl., p. 14.  
1910. *Neohæmatopinus sciuropteri* Mjöberg, Ark. f. Zool., Vol. 6, pt. 13, p. 160, f. 79.  
1912. *Neohæmatopinus sciuropteri* Cummings, Bul. Ent. Res., Vol. 3, p. 393.  
1915. *Neohæmatopinus sciuropteri* Kellogg & Ferris, Anopl. & Mall. of N. Am. Mam., p. 36; pl. 1, f. 1; pl. 5, f. 2, 13.  
1916. *Neohæmatopinus sciuropteri* Ferris, Psyche, Vol. 23 (in press).

Genus *Polyplax* Enderlein

*Polyplax* Enderlein, Zool. Anz., Vol. 28, pp. 139, 142, 223 (1904); Dalla Torre, Gen. Ins., Anopl., p. 13 (1908); Mjöberg, Ark. f. Zool., Vol. 6, pt. 13, p. 159 (1910); Fahrenholz, 2-3-4th Jahresb. Niedersäch. Zool. Ver., pp. 29-30 (1912); Kellogg & Ferris, Anopl. & Mall. of N. Am. Mam., p. 11 (1915).

*Hæmatopinus* (*Polyplax*) Neumann, Arch. de Par., Vol. 13, pp. 529-532 (1909).

*Ercmophthirius* Glinkiewicz, Sitz. d. Kaiserl. Ak. Wiss. Wien, Natur. Klasse, Vol. 116, pp. 381-383 (1907).

Antennæ sometimes differing in the sexes, the male frequently having the third segment with a distal, preaxial process. Anterior legs small with slender claw, middle legs larger with stouter claw, posterior legs somewhat larger and with heavier claw than the middle. Female with most of the abdominal tergites and sternites divided into two transverse plates, each bearing a row of spines or hairs. Male with a smaller number of tergites and sternites thus divided. Pleural plates present. Spiracles small.

One species recorded from *Soricidæ* (Insectivora), one from *Myoxidæ* (Rodentia), the remainder from *Muridæ* (Rodentia).

Type of the genus *Polyplax spinulosa* (Burm.)

- 1—*Polyplax affinis* (Burmeister). From *Apodemus sylvaticus* (Europe). Also from ?*Apodemus agrarius* (Europe).

1839. *Pediculus affinis* Burmeister, Gen. Rhyn., No. 10.

1842. *Hæmatopinus affinis* Denny, Mon. Anopl., p. 36.

1864. *Pediculus affinis* Nitzsch, Zeit. f. ges. Naturw., Vol. 23, p. 22.

1874. *Hæmatopinus affinis* Giebel, Ins. Epizoa, p. 39; pl. 1. f. 9.

1880. *Hæmatopinus acanthopus* var. *affinis* Piaget, Les Ped., p. 639.

1904. *Polyplax affinis* Enderlein, Zool. Anz., Vol. 28, p. 142.

1908. *Polyplax affinis* Dalla Torre, Gen. Ins., Anopl., p. 13.

1912. *Polyplax affinis* Fahrenholz, 2-3-4th Jahresb. Niedersäch. Zool. Ver., pp. 39-42, f. 13-15.

- 2—*Polyplax auricularis* Kellogg & Ferris. Type from *Peromyscus maniculatus rubidus* (California, U. S. A.). Also from *Peromyscus sitchensis prevostensis* (Forrester Is., Alaska), *P. maniculatus gambeli* and *Onychomys torridus pulcher* (California) and *O. leucogaster arcticeps* (Colorado, U. S. A.).

1915. *Polyplax auricularis* Kellogg & Ferris, Anopl. & Mall. of N. Am. Mam., pp. 13-15, t. f. 2; pl. 1, f. 4; pl. 4, f. 8.

1916. *Polyplax auricularis* Ferris, Psyche, Vol. 23 (in press).

- 3—*Polyplax brachyrrhynchus* Cummings. From *Acomys cahirinus* (Egypt).

1914. *Polyplax brachyrrhynchus* Cummings, Proc. Zool. Soc. London, pp. 246-251, t. f. 1-3, 13-14.

- 4—*Polyplax clavicornis* (Nitzsch). From *Meriones* sp. (Northern Africa).

1864. *Pediculus clavicornis* Nitzsch, Zeit. f. ges. Naturw., Vol. 23, p. 32.

1869. *Hæmatopinus clavicornis* Nitzsch & Giebel, Ibid., Vol. 28, p. 397.

1874. *Hæmatopinus clavicornis* Giebel, Ins. Epizoa, pp. 37-38.
1880. *Hæmatopinus clavicornis* Piaget, Les Ped., p. 640.
1904. *Polyplax clavicornis* Enderlein, Zool. Anz., Vol. 28, p. 142.
1908. *Polyplax clavicornis* Dalla Torre, Gen. Ins., Anopl., p. 13.
- 4—*Polyplax cummingsi* Ferris. From *Dasymys incomtus* (Zululand, S. Africa).
1916. *Polyplax cummingsi* Ferris, Ann. Durban Mus., Vol. 2 (in press).
- 5—*Polyplax gracilis* Fahrenholz. Type from *Micromys minutus* (Europe). Also from *Mus chrysophilus* (Zululand, South Africa).
1910. *Polyplax gracilis* Fahrenholz, Zool. Anz., Vol. 35, p. 715.
1912. *Polyplax gracilis* Fahrenholz, 2-3-4th Jahresb. d. Niedersäch. Zool. Ver., pp. 42-44, f. 16-17; pl. 1, f. 10-11.
1916. *Polyplax gracilis* Ferris, Ann. Durban Mus., Vol. 2 (in press).
- 6—*Polyplax jonesi* Kellogg & Ferris. From *Saccostomus campestris* (Zululand, South Africa).
1915. *Polyplax jonesi* Kellogg & Ferris, Ann. Durban Mus., Vol. 1, pt. 2, pp. 151-152; pl. 15, f. 3-3e.
1916. *Polyplax jonesi* Ferris, Ibid., Vol. 2 (in press).
- 7—*Polyplax* ? *miacantha* Speiser. From "einer kleinen Ratte mit sehr dicken, stachelartigen Haaren." (Salomona, Abyssinia).
1905. *Polyplax miacantha* Speiser, Centralbl. f. Bakter., Vol. 38, pt. 1 (Originale), pp. 318-319. (Figure does not belong to it.)
1908. *Polyplax miacantha* Dalla Torre, Gen. Ins., Anopl., p. 13.
- 8—*Polyplax otomydis* Cummings. Type from *Otomys irroratus tropicalis* (British East Africa). Also from *Otomys irroratus* and *O. brantsi luteolus* (South Africa).
1912. *Polyplax otomydis* Cummings, Bul. Ent. Res., Vol. 3, pp. 395-397, f. 2.

1914. *Polyplax otomydis* Waterston, Ann. S. Af. Mus., Vol. 10, p. 275.
1915. *Polyplax otomydis* Kellogg & Ferris, Ann. Durban Mus., Vol. 1, pt. 2, p. 150.
1916. *Polyplax otomydis* Ferris, Ibid., Vol. 2 (in press).
- 9—*Polyplax oxyrrhynchus* Cummings. From *Acomys cahirinus* (Egypt).
1915. *Polyplax oxyrrhynchus* Cummings, Proc. Zool. Soc. Lond., pp. 251-260, 262-265; t. f. 4-6, 8-9, 11-13.
- 10—*Polyplax pectinata* Cummings. From *Epimys aurifer* (Malay Peninsula).
1913. *Polyplax pectinata* Cummings, Bul. Ent. Res., Vol. 4, pp. 35-36.
- 11—*Polyplax* ? *pleurophæa* (Burmeister). From *Dryomys nitedula* (Europe).
1839. *Pediculus pleurophæus* Burmeister, Gen. Rhyn., No. 7.
1864. *Pediculus pleurophæus* Nitzsch, Zeit. f. ges. Naturw., Vol. 23, p. 27.
1874. *Hæmatopinus leucophæus* Giebel, Ins. Epizoa, p. 37.
1880. *Hæmatopinus leucophæus* Piaget, Les Ped., p. 640.
1904. *Polyplax pleurophæa* Enderlein, Zool. Anz., Vol. 28, p. 142.
1908. *Polyplax pleurophæa* Dalla Torre, Gen. Ins., Anopl., p. 13.
- 12—*Polyplax reclinata* (Nitzsch). From *Sorex araneus* (Europe).
1864. *Pediculus reclinatus* Nitzsch, Zeit. f. ges. Naturw., Vol. 23, p. 23.
1874. *Hæmatopinus reclinatus* Giebel, Ins. Epizoa, p. 37.
1880. *Hæmatopinus reclinatus* Piaget, Les Ped., p. 639.
1904. *Polyplax reclinata* Enderlein, Zool. Anz., Vol. 28, p. 142.

1904. *Hoplopleura reclinata* Enderlein, Ibid., Vol. 28, p. 222.
1908. *Hoplopleura reclinata* Dalla Torre, Gen. Ins., Anopl., p. 14.
1910. *Hæmatopinus (Polyplax) spiniger reclinatus* Neumann, Arch. de Par., Vol. 13, pp. 524-525, f. 24.
1912. *Polyplax reclinata* Fahrenholz, 2-3-4th Jahresb. d. Niedersäch. Zool. Ver., pp. 37-39, f. 11-12; pl. 1, f. 12-13; pl. 2, f. 2-4; pl. 3, f. 7.
- 13—*Polyplax serrata* (Burmeister). From *Mus musculus* (Europe).
1839. *Pediculus serratus* Burmeister, Gen. Rhyn., No. 6.
1842. *Hæmatopinus serratus* Denny, Mon. Anopl., p. 36.
1864. *Pediculus serratus* Nitzsch, Zeit. f. ges. Naturw., Vol. 23, p. 27.
1874. *Hæmatopinus serratus* Giebel, Ins. Epizoa, p. 36; pl. 1, f. 6.
1880. *Hæmatopinus serratus* Piaget, Les Ped., p. 639.
1904. *Polyplax serrata* Enderlein, Zool. Anz., Vol. 28, p. 142.
1908. *Polyplax serrata* Dalla Torre, Gen. Ins., Anopl., p. 14.
1913. *Polyplax serrata* Evans, Proc. Roy. Phys. Soc. Edinburgh, Vol. 19, p. 94.
- 14—*Polyplax ? spiculifera* (Gervais). From *Mus barbarus* (Algiers).
1844. *Pediculus spiculifer* Gervais, Aptères, Vol. 3, p. 302.
1874. *Hæmatopinus spiculifer* Giebel, Ins. Epizoa, p. 37.
1880. *Hæmatopinus spiculifer* Piaget, Les Ped., p. 639.
1904. *Polyplax spiculifera* Enderlein, Zool. Anz., Vol. 28, p. 142.
1908. *Polyplax spiculifera* Dalla Torre, Gen. Ins., Anopl., p. 14.

15—*Polyplax spiniger* (Burmeister). From *Arvicola amphibius* (Europe).

1839. *Pediculus spiniger* Burmeister, Gen. Rhyn., No. 9, f. 5.  
1842. *Hæmatopinus spiniger* Denny, Mon. Anopl., p. 27; pl. 24, f. 6.  
1864. *Pediculus spiniger* Nitzsch, Zeit. f. ges. Naturw., Vol. 23, p. 23.  
1874. *Hæmatopinus spiniger* Giebel, Ins. Epizoa, p. 39; pl. 2, f. 1.  
1880. *Hæmatopinus spiniger* Piaget, Les Ped., pp. 637-638; pl. 52, f. 3.  
1904. *Polyplax spinigera* Enderlein, Zool. Anz., Vol. 28, p. 142.  
1908. *Polyplax spinigera* Dalla Torre, Gen. Ins., Anopl., p. 14.  
1909. *Hæmatopinus (Polyplax) spiniger* Neumann, Arch. de Par., Vol. 13, p. 524, f. 24.

16—*Polyplax spinulosa* (Burmeister). Type from *Epimys norvegicus* (Europe). Also from *Epimys rattus* and *E. rattus alexandrinus* (Cosmopolitan) and *Microtus californicus* and *Phenacomys longicaudus* (California, U. S. A.).

1839. *Pediculus spinulosus* Burmeister, Gen. Rhyn., No. 8.  
1842. *Hæmatopinus spinulosus* Denny, Mon. Anopl., p. 26; pl. 24, f. 5.  
1864. *Pediculus denticulatus* Nitzsch, Zeit. f. ges. Naturw., Vol. 23, p. 24.  
1874. *Hæmatopinus spinulosus* Giebel, Ins. Epizoa, pp. 38-39; pl. 1, f. 7.  
1880. *Hæmatopinus spinulosus* Piaget, Les Ped., pp. 636-637; pl. 52, f. 2.  
1891. *Hæmatopinus spinulosus* Osborn, Bul. 7, o. s., U. S. Dept. Agr., Div. Ent., p. 22.  
1896. *Hæmatopinus spinulosus* Osborn, Bul. 5, n. s., U. S. Dept. Agr., Div. Ent., p. 18.  
1904. *Polyplax spinulosa* Enderlein, Zool. Anz., Vol. 28, p. 142.  
1905. *Polyplax spinulosa* Enderlein, Ibid., Vol. 29, pp. 192-194.

1908. *Polyplax spinulosa* Dalla Torre, Gen. Ins., Anopl., p. 14.
1909. *Hæmatopinus (Polyplax) spinulosus* Neumann, Arch. de Par., Vol. 13, p. 526, f. 26.
1910. *Polyplax spinulosa* Mjöberg, Ark. f. Zool., Vol. 6, No. 13, p. 160.
1912. *Polyplax spinulosa* Fahrenholz, 2-3-4th Jahresb. de Niedersäch. Zool. Ver., pp. 30-37, f. 8-10; pl. 2, f. 8-13.
1915. *Polyplax spinulosa* Kellogg & Ferris, Anopl. and Mall. of N. Am. Mam., pp. 12-13; t. f. 1; pl. 5, f. 11a-11b; pl. 6, f. 7.
- 17—*Polyplax stephensi* (Christophers & Newstead). From *Gerbillus indicus* (India).
1906. *Hæmatopinus stephensi* Christophers & Newstead, Rept. Thompson Yates Lab., Liverpool, Vol. 7, p. 3; pl. 1.
1909. *Hæmatopinus (Polyplax) stephensi* Neumann, Arch. de Par., Vol. 13, pp. 525-526, f. 25.
1913. *Hæmatopinus (Polyplax) stephensi* Patton & Cragg, Med. Ent., pp. 550-551; pl. 68, f. 4-6.
- 18—*Polyplax villosa* Galli-Valerio. From *Microtus nivalis* (Europe).
1905. *Polyplax villosa* Galli-Valerio, Zool. Anz., Vol. 28, pp. 521-522.
1908. *Polyplax villosa* Dalla Torre, Gen. Ins., Anopl., p. 14.
- NOTE: Probably not a valid species.
- 19—*Polyplax werneri* (Glinkiewicz). From *Pachyuromys duprasi* (Egypt).
1907. *Eremophthirius werneri* Glinkiewicz, Sitzb. d. Kaiserl. Ak. d. Wissen. Wien. Math. Natur. Klasse, Vol. 116, pp. 381-383.
1910. *Hoplopleura ? werneri* Mjöberg, Ark. f. Zool., Vol. 6, pt. 13, p. 164.

Genus *Scipio* Cummings

Cummings, Bul. Ent. Res., Vol. 3, p. 393 (1913); Ferris Ann. Durban Mus., Vol. 2 (in press).

Antennæ not differing in the sexes. Middle and posterior legs subequal in size, large and with pointed claws. Anterior legs small and slender with slender claw and, arising close beside it, a curved, claw-like process. Abdomen large and soft, entirely without chitinated tergal and sternal plates except in the male, where these plates may be present as very narrow, transverse areas. Each segment with a single transverse row of spines. Pleurites present. Gonapods very short. Spiracles small. Male resembling female except for smaller size.

Recorded only from Octodontidæ (Rodentia).

Type of the genus, *Scipio aulacodi* (Neumann).

- 1—*Scipio aulacodi* (Neumann). Type from *Thryonomys swinderianus* (Africa). Also from *Thryonomys* sp. (Zululand, South Africa).

1911. *Hæmatopinus aulacodi* Neumann, Arch. de Par., Vol. 14, pp. 403-406, f. 5-7.

1913. *Scipio aulacodi* Cummings, Bul. Ent. Res., Vol. 3, p. 393.

1916. *Scipio aulacodi* Ferris, Ann. Durban Mus., Vol. 2 (in press).

- 2—*Scipio breviceps* Ferris. From *Thryonomys* sp. (Zululand, South Africa).

1916. *Scipio breviceps* Ferris, Ann. Durban Mus., Vol. 2 (in press).

#### *Linognathinæ* of Uncertain Position

- 1—*Hæmatopinus (Polyplax) præcisus* Neumann. From "gros Rats" (Abyssinia).

1901. *Hæmatopinus præcitus* (typographical error for *præcisus*) Neumann, Arch. de Par., Vol. 5, pp. 600-601.

1902. *Hæmatopinus præcisus* Neumann, Ibid., Vol. 6, p. 144, fig.

1908. *Polyplax* ? *præcisus* Dalla Torre, Gen. Ins., Anopl., p. 13.

1909. *Hæmatopinus (Polyplax) præcisus* Neumann, Arch. de Par., Vol. 13, pp. 523-524, f. 23.

NOTE: This seems to include the male of one species and the female of another; it is probable that they belong to different genera.

2—*Hæmatopinus (Linognathus) squamulatus* Neumann.  
From unknown host (Dire-Daoua, Abyssinia).

1911. *Hæmatopinus (Linognathus) squamulatus* Neumann, Arch. de Par., Vol. 14, pp. 401-403; f. 1-4.

NOTE: This is neither *Hæmatopinus* nor *Linognathus*; it approaches *Scipio* in certain respects, but possibly represents an undescribed genus.

3—*Hæmodipsus parvus* Kellogg & Ferris. From *Lagidium peruanum* (Peru, South America).

1915. *Hæmodipsus parvus* Kellogg & Ferris, Anopl. and Mall. of N. Am. Mam., pp. 30-32, t. f. 12; pl. 2, f. 4; pl. 4, f. 6.

NOTE: This may possibly belong to *Eulinognathus*. The species was described from immature specimens.

#### Subfamily *Euhæmatopiniæ*.

Enderlein, Zool. Anz., Vol. 28, pp. 136, 138 (1904); Dalla Torre, Gen. Ins. Anopl., p. 15 (1908).

Separated from the other subfamilies of the *Hæmatopiniæ* only because of the three-segmented antennæ.

#### Genus *Euhæmatopinus* Osborn

Osborn, Bul. 5, n. s., U. S. Dept. Agr., Div. Ent., p. 186 (1896); Enderlein, Zool. Anz., Vol. 28, pp. 136, 140 (1904); Dalla Torre, Gen. Ins., Anopl., p. 16 (1908); Kellogg & Ferris, Anopl. & Mall. of N. Am. Mam., pp. 46-47 (1915).

Anterior and middle legs of nearly same size; posterior legs much larger and heavier, with broad, heavy claw, and with a stalked, disk-shaped appendage on femur and tibia. No tergal and sternal plates. Pleural plates present.

Type of the genus, *Euhæmatopinus abnormis* Osborn.

1—*Euhæmatopinus abnormis* Osborn. From *Scalopus aquaticus* (Iowa, U. S. A.).

1896. *Euhæmatopinus abnormis* Osborn, Bul. 5, n. s., U. S. Dept. Agr., Div. Ent., p. 187.

1908. *Euhæmatopinus abnormis* Dalla Torre, Gen. Ins., Anopl., p. 16.

1915. *Euhæmatopinus abnormis* Kellogg & Ferris, Anopl. and Mall. of N. Am. Mam., pp. 47-48; t. f. 16; pl. 3, f. 3; pl. 5, f. 4, 9.

Genus *Hæmatopinoides* Osborn.

Osborn, Bul. 7, o. s., U. S. Dept. Agr., Div. Ent., p. 28 (1891); Bul. 5, n. s., p. 187 (1896); Enderlein, Zool. Anz., Vol. 28, pp. 136, 140 (1904); Dalla Torre, Gen. Ins., Anopl., p. 15 (1908); Kellogg & Ferris, Anopl. and Mall. of N. Am. Mam., p. 46 (1915).

Anterior and middle legs small, posterior legs much larger, without stalked, disk-shaped appendages on femur and tibia. Abdomen without chitinized tergal and sternal plates. Pleural plates present.

Type of the genus, *Hæmatopinoides squamosus* Osborn.

1—*Hæmatopinoides squamosus* Osborn. From *Geomys bur-sarius*. (Iowa, U. S. A.).

1891. *Hæmatopinoides squamosus* Osborn, Bul. 7, o. s., U. S. Dept. Agr., Div. Ent., p. 28, f. 16.  
 1896. *Hæmatopinoides squamosus* Osborn, Bul. 5, n. s., U. S. Dept. Agr., Div. Ent., pp. 187-188, f. 110.  
 1908. *Hæmatopinoides squamosus* Dalla Torre, Gen. Ins., Anopl., p. 15.  
 1915. *Hæmatopinoides squamosus* Kellogg & Ferris, Anopl. and Mall. of N. Am. Mam., pp. 46-47.

Family *Echinophthiriidæ*

*Echinophthiriidæ* Enderlein, Zool. Anz., Vol. 28, pp. 136, 137 (1904); Ibid., Vol. 29, p. 661 (1906); Deut. Südpolar Exp., Vol. 10, pp. 505-506 (1909); Dalla Torre, Gen. Ins., Anopl., p. 17 (1908).

*Lepidophthiriidæ* (in part) Mjöberg, Ark. f. Zool., Vol. 6, pt. 13, p. 177 (1910).

Antennæ four- or five-segmented. Legs with a thumb-like process opposing the claw, the anterior pair small with slender claw, the other pairs extremely large with blunt, heavy claws. Abdomen without pleural, tergal or sternal plates.

Thorax and abdomen thickly beset with spines or with spines and delicate scales. Occurring only on marine mammals.

Subfamily *Echinophthiriinae*

Enderlein, Deut. Südpolar Exp., Vol. 10, p. 506 (1909).

Antennæ four-segmented. Abdomen thickly beset with spines but without scales.

Genus *Echinophthirius* Giebel

Giebel, Zeitschrift f. ges. Naturw., Vol. 37, p. 177 (1871); Piaget, Les Ped., p. 656 (1880); Dalla Torre, Gen. Ins., Anopl., p. 17 (1908); Enderlein, Zool. Anz., Vol. 28, p. 137 (1904); *Ibid.*, Vol. 29, p. 661 (1906); Deut. Südpolar Exp., Vol. 10, p. 507 (1909).

Antennæ four-segmented. Body without scales but thickly beset with stout spines.

From *Pinnipedia*. Type of the genus *Echinophthirius phocæ* (Lucas).

1—*Echinophthirius groenlandicus* (Becker). From *Phoca groenlandica* (Jan Mayen Island).

1886. *Echinophthirius groenlandicus* Becker, Österreichische Polarforschung, Vol. 3, Ins. von Jan Mayen, p. 60; pl. 5, f. 1-1a.

1908. *Echinophthirius groenlandicus* Dalla Torre, Gen. Ins., Anopl., p. 17.

1909. *Echinophthirius groenlandicus* Enderlein, Deut. Südpolar Exp., Vol. 10, p. 507.

2—*Echinophthirius phocæ* (Lucas). Type from (?) *Phoca vitulina* (Europe). Also from *P. groenlandica*, *P. variegata* (Atlantic Ocean), "harbor seals" (Aquarium, New York City), and "see hunde" (Helgoland).

1834. *Pediculus phocæ* Lucas, Mag. Zool. Ins., p. 121; pl. 12, f. 1.

1842. *Hamatopinus setosus* Denny, Mon. Anopl., p. 36.

1857. *Hamatopinus annulatus* Schilling, Arch. f. Naturgesc., Vol. 23, p. 281.

1874. *Hæmatopinus setosus* Giebel, Ins. Epizoa, pp. 42-43.
1880. *Echinophthirius setosus* Piaget, Les Ped., pp. 656-658; pl. 54—, f. 1.
1896. *Echinophthirius setosus* Osborn, Bul. 5, n. s., U. S. Dept. Agr., Div. Ent., p. 188.
1904. *Echinophthirius phocæ* Enderlein, Zool. Anz., Vol. 28, p. 136.
1908. *Echinophthirius phocæ* Dalla Torre, Gen. Ins., Anopl., p. 17.
1909. *Echinophthirius phocæ* Enderlein, Deut. Südpolar Exp., Vol. 10, p. 507.
1910. *Echinophthirius phocæ* Mjöberg, Ark. f. Zool., Vol. 6, pt. 13, p. 176.
1913. *Echinophthirius phocæ* Evans, Proc. Roy. Phys. Soc., Edinburgh, Vol. 19, p. 95, fig.
- 3—*Echinophthirius sericeus* Meinert. From *Phoca* sp. (Greenland).
1896. *Echinophthirius sericeus* Meinert, Vedenskabelige Meddelelser, p. 177.
1908. *Echinophthirius sericeus* Dalla Torre, Gen. Ins., Anopl., p. 18.

#### Subfamily *Antarctophthiriinæ*

Enderlein, Deut. Südpolar Exp., Vol. 10, p. 506 (1909).

Antennæ four- or five-segmented. Thorax and abdomen beset with many stout spines and with delicate scales.

#### Genus *Antarctophthirus* Enderlein

*Antarctophthirus* Enderlein, Zool. Anz., Vol. 29, p. 661 (1906); Deut. Südpolar Exp., Vol. 10, p. 506 (1909); Dalla Torre, Gen. Ins., Anopl., p. 17 (1908); Kellogg & Ferris, Anopl. and Mall. of N. Am. Mam., p. 48 (1915).

*Arctophthirus* (in part) Mjöberg, Ark. f. Zool., Vol. 6, pt. 13, p. 178-179 (1910).

Antennæ five-segmented. Anterior legs and claws much smaller than the others, which are extraordinarily large and stout. No sternal plate. No pleural plates. Abdomen and

thorax beset with a great number of short stout spines and with extremely delicate scales. Spiracles small.

From various marine Mammals.

Type of the genus, *Antarctophthirus ogmorhini* Enderlein.

- 1—*Antarctophthirus lobodontis* Enderlein. From *Lobodon carcinophagus*. (Booth Wandel Is).

1909. *Antarctophthirus lobodontis* Enderlein, Deut. Südpolar Exp., Vol. 10, pt. 4, p. 476.

- 2—*Antarctophthirus michrochir* (Trouessart & Neumann). From *Phocarctos hookeri* (Auckland Island). Also from *Zalophus californianus* (California), (unpublished record).

1888. *Echinophthirus michrochir* Trouessart & Neumann, Le Naturaliste, Vol. 10, p. 80.

1908. *Echinophthirus michrochir* Dalla Torre, Gen. Ins., Anopl., p. 17.

1909. *Antarctophthirus michrochir* Enderlein, Deut. Südpolar Exp., Vol. 10, pp. 511-512; f. 176, 177, 183, 184.

- 3—*Antarctophthirus monachus* Kellogg & Ferris. From "seal." Locality unknown.

1915. *Antarctophthirus monachus* Kellogg & Ferris, Anopl. and Mall. of N. Am. Mam., pp. 49-51; t. f. 17a, 18; pl. 3, f. 4.

- 4—*Antarctophthirus ogmorhini* Enderlein. From *Ogmorhinus leptonyx*. (Victoria Land).

1902. *Echinophthirus setosus* Rothschild, Rept. Sou. Cross Exp., p. 224.

1906. *Antarctophthirus ogmorhini* Enderlein, Zool. Anz., Vol. 29, p. 662, f. 1-2.

1907. *Antarctophthirus ogmorhini* (in part) Neumann, Exp. Antarc. Franc. Arth., p. 13.

1908. *Antarctophthirus ogmorhini* Dalla Torre, Gen. Ins., Anopl., p. 17.

1909. *Antarctophthirus ogmorhini* Enderlein, Deut. Südpolar Exp., Vol. 10, pp. 509-510, f. 174, 175, 181, 182.

- 5—*Antarctophthirus trichechi* (Boheman). Type from *Odobænus rosmarus* (Europe). Also from *Odobænus obes* (Pacific Ocean).

- 1866. *Hæmatopinus trichechi* Boheman, Oefversigt af K. Vetenskaps-Akad. Förhandlingar, Vol. 22, p. 577; pl. 35, f. 2.
- 1880. *Hæmatopinus trichechi* Piaget, Les Ped., p. 656.
- 1908. *Hæmatopinus trichechi* Dalla Torre, Gen. Ins., Anopl., p. 11.
- 1909. *Antarctophthirus trichechi* Neumann, Arch. de Par., Vol. 13, pp. 532-537, f. 30-31.
- 1909. *Antarctophthirus trichechi* Enderlein, Deut. Südpolar Exp., Vol. 10, pp. 502, 512-513; pl. 55-56.
- 1910. *Arctophthirus trichechi* Mjöberg, Ark. f. Zool., Vol. 6, pt. 13, pp. 178-180, f. 89-92.
- 1915. *Antarctophthirus trichechi* Kellogg & Ferris, Anopl. and Mall. of N. Am. Mam., p. 49, t. f. 17b; pl. 3, f. 1.

Genus *Lepidophthirus* Enderlein

Enderlein, Zool. Anz., Vol. 28, pp. 43, 137 (1904); Ibid., Vol. 29, p. 661 (1905); Dalla Torre, Gen. Ins., Anopl., p. 18 (1908); Enderlein, Deut. Südpolar Exp., Vol. 10, pp. 513-514 (1909).

Antennæ four-segmented. Spiracles present on both meso- and metathorax and on second to eighth abdominal segments. Anterior legs small, others very large. Thorax and abdomen beset with delicate scales and with many spines.

Type of the genus *Lepidophthirus macrorhini* Enderlein.

1—*Lepidophthirus macrorhini* Enderlein. From *Macrorhinus leoninus* (Kerguelen Island).

- 1904. *Lepidophthirus macrorhini* Enderlein, Zool. Anz., Vol. 28, pp. 46-47, f. 1-5.
- 1908. *Lepidophthirus macrorhini* Dalla Torre, Gen. Ins., Anopl., p. 18.
- 1909. *Lepidophthirus macrorhini* Enderlein, Deut. Südpolar Exp., Vol. 10, pp. 515-516, f. 178-180, t. f. OO, QQ.

Family *Hæmatomysidæ*

Enderlein, Zool. Anz., Vol. 28, pp. 136, 137 (1904); Dalla Torre, Gen. Ins., Anopl., p. 19 (1908).

Head much produced anteriorly with the mouth opening at the apex. Antennæ five-segmented. Legs long and slender, of nearly equal size, without a thumb-like process opposing the claw.

Genus *Hæmatomyzus* Piaget

*Hæmatomyzus* Piaget, Tijds. v. Ent., Vol. 12, p. 254 (1869); Günther, Science Gossip, p. 278 (1871); Piaget, Les Ped., p. 658 (1880); Enderlein, Zool. Anz., Vol. 28, p. 137 (1904); Dalla Torre, Gen. Ins., Anopl., p. 19 (1908).

*Idolocoris* Walker & Richter, Science Gossip, pp. 131, 211 (1871).

*Phantasmocoris* White, Science Gossip, pp. 234, 278 (1871).

Head tubularly produced anteriorly, with the mouth opening at the apex. Antennæ five-segmented. Legs long and slender, without a thumb-like process opposing the claw.

Type of the genus, *Hæmatomyzus elephantis* Piaget.

1—*Hæmatomyzus elephantis* Piaget. From African elephant.

1869. *Hæmatomyzus elephantis* Piaget, Tijds. v. Ent., Vol. 4, ser. 2, p. 254; pl. 2, f. 1-14.

1871. *Idolocoris elephantis* Richter, Science Gossip, p. 132, f. 67.

1871. *Hæmatomyzus elephantis* Newman, The Entomologist, Vol. 6, pp. 465-470, fig.

1880. *Hæmatomyzus proboscideus* Piaget, Les Ped., pp. 658-660; pl. 54, f. 2.

1908. *Hæmatomyzus elephantis* Dalla Torre, Gen. Ins., Anopl., p. 19.

1910. *Hæmatomyzus proboscideus* Mjöberg, Ark. f. Zool., Vol. 6, pt. 13, pp. 181-183, f. 93.

1a—*Hæmatomyzus elephantis* var. *sumatranus* Fahrenholz. From *Elephas indicus* (Sumatra).

1910. *Hæmatomyzus elephantis* var. *sumatranus* Fahrenholz, Zool. Anz., Vol. 35, p. 714.

1910. *Hæmatomyzus elephantis* var. *sumatranus* Fahrenholz, Jahresb. d. Niedersäch. Zool. Ver., Vol. 58-59, Abt. D, p. 67.

## HOST LIST OF THE ANOPLURA

The arrangement of the orders is that adopted by Osborn in "The Age of Mammals" (1914). In each case the first name given is the correct name, as nearly as it has been possible to establish it. The names in parentheses are synonyms that have been used in connection with discussions of the Anoplura.

## Order INSECTIVORA

## Family TALPIDÆ

*Scalopus aquaticus machrinus?* (*Scalops argentatus*).

*Euhæmatopinus abnormis* Osborn (Ames, Iowa, U. S. A.).

## Family SORICIDÆ

*Sorex araneus* (*Sorex vulgaris*).

*Polyplax reclinatus* (Burm.) (Europe).

?*Hoplopleura acanthopus* (Burm.) (Europe).

## Order CARNIVORA

## Suborder FISSIPEDIA

## Family CANIDÆ

*Canis familiaris* (Domestic dog).

*Linognathus piliferus* (Burm.) (Cosmopolitan).

## Family MUSTELIDÆ

"Ferret."

*Linognathus piliferus* (Burm.) (England).

## Suborder PINNIPEDIA

## Family ODOBÆNIDÆ

*Odobænus rosmarus* (*Trichechus rosmarus*, Walrus).

*Antarctophthirus trichechi* (Boh.) (North Atlantic).

*Odobænus obes* (Pacific Walrus).

*Antarctophthirus trichechi* (Boh.) (North Pacific).

## Family PHOCIDÆ

*Phoca groenlandica*.

*Echinophthirius groenlandica* (Becker) (Jan Mayen Island).

*Phoca variegata*.

*Echinophthirius phocæ* (Lucas) (Europe).

*Phoca vitulina*.

*Echinophthirius phocæ* (Lucas) (Europe).

*Phoca* sp.

*Echinophthirius sericeus* Meinert (Greenland).

*Macrorhinus leoninus*.

*Lepidophthirus macrorhini* End. (Victorialand).

*Lobodon carcinophaga*.

*Antarctophthirus lobodontis* End. (Booth Wandel Is.).

*Ogmorhinus leptonyx*.

*Antarctophthirus ogmorhini* End. (Kerguelen Is.).

## Family OTARIIDÆ

*Phocarcos hookeri*.

*Antarctophthirus microchir* (Troues. & Neum.) (Auckland Is.).

*Zalophus californianus*.

*Antarctophthirus microchir* (Troues. & Neum.) (California).

## Of Uncertain Position

"Harbor Seal."

*Echinophthirius phocæ* (Lucas) (Aquarium, New York City).

"Seal."

*Antarctophthirus monachus* Kellogg & Ferris (Locality unknown).

"Seehunde."

*Echinophthirius phocæ* (Lucas) (Helgoland).

## Order RODENTIA

## Suborder DUPLICIDENTATA

## Family LEPORIDÆ

*Lepus californicus*.

*Hæmodipsus ventricosus* (Denny) (California, U. S. A.).

*Lepus californicus deserticola*.

*Hæmodipsus ventricosus* (Denny) (Ehrenberg, Arizona, U. S. A.).

*Lepus campestris* (Prairie Hare).

*Hæmodipsus ventricosus* (Denny) (Ames, Iowa, U. S. A.).

*Lepus europæus occidentalis* (*Lepus europæus*).

*Hæmodipsus lyriocephalus* (Burm.) (Tynninghame, Scotland).

*Lepus timidus*.

*Hæmodipsus ventricosus* (Denny) (Europe).

*Hæmodipsus lyriocephalus* (Burm.) (Europe).

*Oryctolagus cuniculus* (Kaninchen, *Lepus cuniculus*).

*Hæmodipsus ventricosus* (Denny) (Europe).

"Domestic rabbit."

*Hæmodipsus ventricosus* (Denny) (Europe, North America).

#### Suborder SIMPLICIDENTATA

##### Family SCIURIDÆ

##### Subfamily ARCTOMYINÆ

*Ammospermophilus nelsoni*.

*Enderleinellus suturalis* (Osborn) (Bakersfield, California, U. S. A.).

*Callospermophilus chrysodeirus*.

*Enderleinellus suturalis* var. *occidentalis* K. & F. (South Yolla Bolly Mt. and Yosemite Valley, California, U. S. A.).

*Citellus barrowensis* ? (*Spermophilus* sp.).

*Linognathoides montanus* (Osborn) (Pt. Barrow, Alaska).

*Citellus beecheyi beecheyi* (*Citellus beecheyi douglasi*).

*Linognathoides montanus* (Osborn) (Palo Alto, California, U. S. A.).

*Enderleinellus osborni* K. & F. (Palo Alto, California, U. S. A.).

*Citellus beldingi*.

*Enderleinellus suturalis* (Osborn) (Yosemite Nat. Park, California, U. S. A.).

*Linognathoides montanus* (Osborn) (California, U. S. A.).

- Citellus columbianus* (*Spermophilus columbianus*).  
    *Linognathoides montanus* (Osborn) (Pullman, Washington, U. S. A.).
- Citellus douglasi* (*Citellus beecheyi douglasi*).  
    *Enderleinellus osborni* K. & F. (Cazadero, California, U. S. A.).  
    *Linognathoides montanus* (Osborn) (Cazadero, California, U. S. A.).
- Citellus eversmanni* (*Spermophilus eversmanni*).  
    *Linognathoides læviusculus* (Grube) (Jakutsk, Siberia; Pitlekaj).
- Citellus franklini* (*Spermophilus franklini*).  
    *Enderleinellus suturalis* (Osborn) (Ames, Iowa, U. S. A.).
- Citellus grammurus*.  
    *Linognathoides montanus* (Osborn) (Santa Catalina Mts., Arizona, U. S. A.).
- Citellus leptodactylus*.  
    *Linognathoides citelli* Cum. (Transcaspia).
- Citellus mexicanus* ?  
    *Linognathoides montanus* (Osborn) (Guanajuato, Mexico).
- Citellus mollis*.  
    *Enderleinellus suturalis* (Osborn) (Virginia Valley, Nevada, U. S. A.).
- Citellus oregonus*.  
    *Enderleinellus suturalis* (Osborn) (Pine Forest Mts., Nevada, U. S. A.).  
    *Linognathoides montanus* (Osborn).
- Citellus plesius ablusus*.  
    *Linognathoides montanus* (Osborn) (Prince William Sound, Alaska).
- Citellus townsendi*.  
    *Enderleinellus suturalis* (Osborn) (Wallula, Washington, U. S. A.).
- Citellus tridecemlineatus* (*Spermophilus tridecemlineatus*).  
    *Enderleinellus suturalis* (Osborn) (Ames, Iowa, U. S. A.).
- Citellus* sp. ? ("Rock Squirrel").  
    *Linognathoides montanus* (Osborn) (Boulder, Colorado, U. S. A.).

*Citellus* sp. ? ("Western Gray Squirrel").

*Linognathoides montanus* (Osborn) (Ft. Collins, Colorado, U. S. A.).

*Cynomys gunnisoni*.

*Enderleinellus suturalis* (Osborn) (Florissant, Colorado, U. S. A.).

*Cynomys leucurus*.

*Enderleinellus suturalis* (Osborn) (Routt County, Colorado, U. S. A.).

*Marmota flaviventer sierræ*.

*Linognathoides montanus* (Osborn) (California, U. S. A.).

*Marmota flaviventer* ssp. ?

*Linognathoides montanus* (Osborn) (Burns, Oregon, U. S. A.).

*Marmota pruinosa*.

*Linognathoides* sp. (North America).

*Xerospermophilus tereticaudus*.

*Enderleinellus suturalis* (Osborn) (Imperial County, California, U. S. A.).

#### Subfamily SCIURINÆ

*Sciurus arizonensis huachuca*.

*Enderleinellus longiceps* K. & F. (Huachuca Mts., Arizona, U. S. A.).

*Sciurus douglasi albolimbatus*.

*Enderleinellus sphærocephalus* (Nitzsch) (Yosemite Nat. Park, California, U. S. A.).

*Hoplopleura arboricola* K. & F. (Yosemite Nat. Park, California, U. S. A.).

*Neohæmatopinus antennatus* var. *semifasciatus* Ferris (Yosemite Nat. Park, California, U. S. A.).

*Sciurus douglasi mollipilosus*.

*Hoplopleura arboricola* K. & F. (Cazadero, California, U. S. A.).

*Neohæmatopinus antennatus* var. *semifasciatus* Ferris (Cazadero, California, U. S. A.).

*Sciurus griseus griseus.*

*Enderleinellus kelloggi* Ferris (Mariposa County, California, U. S. A.).

*Hoplopleura arboricola* K. & F. (Mariposa County, California, U. S. A.).

*Neohæmatopinus antennatus* (Osborn) (Mariposa County, California, U. S. A.).

*Sciurus griseus nigripes.*

*Enderleinellus kelloggi* Ferris (Stanford University, California, U. S. A.).

*Hoplopleura arboricola* K. & F. (Stanford University, California, U. S. A.).

*Sciurus hudsonicus petulans.*

*Enderleinellus sphærocephalus* (Burm.) (Glacier Bay, Alaska).

*Sciurus hudsonicus vancouverensis.*

*Enderleinellus sphærocephalus* (Burm.) (Kuiu Island, Alaska).

*Sciurus niger rufiventer* (*Sciurus cinereus ludovicianus*).

*Enderleinellus longiceps* K. & F. (De Kalb County, Indiana, U. S. A.).

*Neohæmatopinus antennatus* (Osborn) (Ames, Iowa, U. S. A.).

*Sciurus palmarum.*

*Hoplopleura maniculata* (Neum.) (Rajkote, India).

*Neohæmatopinus echinatus* (Neum.) (Rajkote, India).

*Sciurus vulgaris.*

*Enderleinellus sphærocephalus* (Burm.) (Europe).

*Sciurus niger* ? (*Sciurus vulpinus*).

*Neohæmatopinus sciurinus* (Mjöberg) (Zool. Mus. Hamburg).

*Sciurus niger rufiventer* or *S. carolinensis carolinensis* ("Western Gray Squirrel").

*Enderleinellus longiceps* K. & F. (Lincoln, Nebraska, U. S. A.).

*Tamias striatus.*

*Hoplopleura arboricola* K. & F. (Ames, Iowa, U. S. A.).

*Hoplopleura erratica* (Osborn) (= *H. arboricola* K. & F.?) (Iowa, U. S. A.).

*Eutamias alpinus.*

*Neohæmatopinus pacificus* K. & F. (Yosemite Nat. Park, California, U. S. A.).

*Hoplopleura arboricola* K. & F. (Yosemite Nat. Park, California, U. S. A.).

*Eutamias hindsi.*

*Neohæmatopinus pacificus* K. & F. (Marin County, California, U. S. A.).

*Eutamias merriami pricei*

*Hoplopleura arboricola* K. & F. (Stanford University, California, U. S. A.).

*Eutamias speciosus frater.*

*Hoplopleura arboricola* K. & F. (Yosemite Nat. Park, California, U. S. A.).

*Neohæmatopinus pacificus* K. & F. (Yosemite Nat. Park, California, U. S. A.).

*Eutamias sonomæ.*

*Neohæmatopinus pacificus* K. & F. (Cazadero, Sonoma County, and Sanhedrin Mt., Mendocino County, California, U. S. A.).

*Hoplopleura arboricola* K. & F. (Cazadero, Sonoma County, and Sanhedrin Mt., Mendocino County, California, U. S. A.).

*Eutamias townsendi ochrogenys.*

*Hoplopleura arboricola* K. & F. (Freestone and Cazadero, Sonoma County, California, U. S. A.).

*Neohæmatopinus pacificus* K. & F. (Freestone and Cazadero, Sonoma County, California, U. S. A.).

*Heliosciurus palliatus.*

*Neohæmatopinus heliosciuri* Cumm. (Uchweni Forest, Witu, British East Africa).

## Subfamily XERINÆ

*Xerus getulus.*

*Linognathoides pectinifer* (Neum.) (Northern Africa).

## Family PETAURISTIDÆ

*Glaucomys sabrinus* ssp. (*Sciuropterus* sp.)

*Hoplopleura trispinosa* K. & F. (Eureka, California, and Brownsville, Oregon, U. S. A.).

*Glaucomys sabrinus lascivus.*

*Enderleinellus uncinatus* Ferris (Yosemite Nat. Park, California, U. S. A.).

*Hoplopleura trispinosa* K. & F. (Yosemite Nat. Park, California, U. S. A.).

*Neohæmatopinus sciuropteri* (Osborn) (Yosemite Nat. Park, California, U. S. A.).

*Glaucomys volans* (*Sciuropterus volucella*, *Pteromys volucella*)

*Hoplopleura trispinosa* K. & F. (Kensington, Maryland, U. S. A.).

*Hoplopleura erratica* (Osborn) (= *H. trispinosa* K. & F.?) (Iowa, U. S. A.).

*Neohæmatopinus sciuropteri* (Osborn) (Iowa, U. S. A.).

## Family HETEROMYIDÆ

*Dipodomys deserti.*

*Fahrenholzia pinnata* K. & F. (Mecca, Riverside County, California, U. S. A.).

*Dipodomys californicus.*

*Fahrenholzia pinnata* K. & F. (Covelo, California, U. S. A.).

*Dipodomys merriami.*

*Fahrenholzia pinnata* K. & F. (Inyo County, California, U. S. A.).

*Microdipodops polionotus.*

*Fahrenholzia pinnata* K. & F. (Benton, Mono County, California, U. S. A.).

*Perognathus californicus.*

*Fahrenholzia tribulosa* Ferris (Mariposa County, California, U. S. A.).

*Perognathus formosus.*

*Fahrenholzia tribulosa* Ferris (Victorville, California, U. S. A.).

*Perognathus parvus olivaceus.*

*Fahrenholzia pinnata* K. & F. (Pine Forest Mts., Nevada, U. S. A.).

*Perodipus* sp.

*Fahrenholzia pinnata* K. & F. (Coulterville, Mariposa County, California, U. S. A.)

## Family GEOMYIDÆ

*Geomys bursarius*.

*Hæmatopinoides squamosus* Osborn (Ames, Iowa, U. S. A.).

## Family MUSCARDINIDÆ

*Dryomys nitedula* (*Myoxus nitella*).

*Polyplax pleurophæa* (Burm.) (Europe).

## Family MURIDÆ

## Subfamily MURINÆ

*Cricetulus phæus*.

*Linognathoides citelli* Cumm. (Transcaspia).

NOTE: *Cricetulus* is probably not the normal host of this species.

*Mus musculus*.

*Polyplax serrata* (Burm.) (Europe).

*Hoplopleura acanthopus* (Burm.) (Europe).

• *Hoplopleura hesperomydis* (Osborn) (California, U. S. A.).

*Mus chrysophilus*.

*Polyplax gracilis* Fahr. (Mfongosi, Zululand, South Africa).

*Mus coucha*.

*Hoplopleura intermedia* K. & F. (Mfongosi, Zululand, South Africa).

*Mus barbarus*.

*Polyplax* ? *spiculifera* (Gerv.) (Algiers).

*Apodemus agrarius* (*Mus agrarius*).

*Polyplax affinis* (Burm.) (Europe).

*Apodemus sylvaticus* (*Mus sylvaticus*).

*Polyplax affinis* (Burm.) (Europe).

*Polyplax spinulosa* (Burm.) (Europe).

*Micromys minutus* (*Mus minutus*).

*Hoplopleura longula* (Neum.).

*Polyplax gracilis* Fahr. (Europe).

*Epimys norvegicus* (*Mus norvegicus*, *Mus decumanus*, *Wanderratte*).

*Polyplax spinulosa* (Burm.) (Cosmopolitan).

*Epimys rattus* (Mus *rattus*).

*Polyplax spinulosa* (Burm.) (Cosmopolitan).

*Hoplopleura bidentata* (Neum.) (Lake Torrens, Australia).

*Epimys rattus alexandrinus* (Mus *alexandrinus*).

*Polyplax spinulosa* (Burm.).

*Epimys surifer*.

*Polyplax pectinata* Cumm. (Biserat, Jalor, Malay Peninsula).

*Acomys caharinus*.

*Polyplax brachyrrhynchus* Cumm. (Assiut, Egypt).

*Polyplax oxyrrhynchus* Cumm. (Assiut, Egypt).

*Arvicanthis dorsalis*.

*Hoplopleura enormis* K. & F. (Mfongosi, Zululand, South Africa).

*Dasymys incomtus* Ferris.

*Polyplax cummingsi* Ferris (Mfongosi, Zululand, South Africa).

*Saccostomus campestris*.

*Polyplax jonesi* K. & F. (Mfongosi, Zululand, South Africa).

#### Subfamily GERBILLINÆ

*Gerbillus indicus*.

*Polyplax stephensi* (Christ. & News.) (India).

*Meriones* sp.

*Polyplax* ? *clavicornis* (Nitzsch) (Abyssinia).

*Pachyuromys duprasi*.

*Polyplax werner* (Glink.) (Natrontal, Egypt).

#### Subfamily OTOMYINÆ

*Otomys brantsi luteolus*.

*Polyplax otomydis* Cumm. (South African Museum, Cape Town).

*Otomys irroratus*.

*Polyplax otomydis* Cumm. (Mfongosi, Zululand, South Africa).

*Otomys irroratus tropicalis*.

*Polyplax otomydis* Cumm. (Mt. Kenya, British East Africa).

## Subfamily MICROTINÆ

- Arvicola amphibius* (*Paludicola amphibius*).  
    *Polyplax spiniger* (Burm.) (Europe).  
*Dicrostonyx torquatus* (*Lemmus torquatus*).  
    *Hoplopleura acanthopus* (Burm.) (Pitlekaj).  
*Lemmus obensis*.  
    *Hoplopleura hispida* (Grube) (Jakutsk, Siberia).  
*Microtus agrestis*.  
    *Hoplopleura acanthopus* (Burm.) (Europe).  
*Microtus arvalis*.  
    *Hoplopleura acanthopus* (Burm.) (Europe).  
*Microtus californicus*.  
    *Polyplax spinulosa* (Burm.).  
    *Hoplopleura acanthopus* var. *americanus* K. & F.  
*Microtus mordax*.  
    *Polyplax spinulosa* (Burm.) (Tuolumne Meadows, California, U. S. A.).  
*Microtus nivalis*.  
    *Polyplax villosa* Galli-Valerio (Switzerland).  
*Microtus* (*Lagurus*) *intermedius*.  
    *Hoplopleura acanthopus* var. *americanus* K. & F.  
    *Polyplax spinulosa* (Burm.) (Pine Forest Mts., Nevada, U. S. A.).  
*Microtus pennsylvanicus* (*Arvicola pennsylvanica*).  
    *Hoplopleura erratica* (Osborn).  
*Microtus* sp. (*Arvicola* sp.).  
    *Hoplopleura acanthopus* var. *americanus* K. & F. (Ames, Iowa, U. S. A.).  
*Phenacomys longicaudus* (*Phenacomys* sp.).  
    *Polyplax spinulosa* (Burm.) (Mendocino City, California, U. S. A.).

## Subfamily CRICETINÆ

- Holochilus squamipes*. (This is possibly *Nectomys apicalis*).  
    *Hoplopleura quadridentata* (Neum.) (Peru, South America).  
*Neotoma cinerea cinerea*.  
    *Linognathoides inornatus* K. & F. (Yosemite Nat. Park, California, U. S. A.).

*Neotoma cinerea occidentalis*.

*Linognathoides inornatus* K. & F. (South Yolla Bolly Mt.;  
Tehama County, California, U. S. A.).

*Neotoma fuscipes streator*.

?*Linognathoides inornatus* K. & F. (Yosemite Nat. Park,  
California, U. S. A.).

*Nesoryzomys indefessus*.

*Hoplopleura quadridentata* (Neum.) (Galapagos Is.).

*Nesoryzomys narboroughi*.

*Hoplopleura quadridentata* (Neum.) (Galapagos Is.).

*Peromyscus boylei*.

*Hoplopleura hesperomydis* (Osborn) (Lakeport, Lake  
County, California, U. S. A.).

*Peromyscus maniculatus rubidus*.

*Hoplopleura hesperomydis* (Osborn).

*Polyplax auricularis* K. & F. (Marin County, California,  
U. S. A.).

*Peromyscus maniculatus gambeli*.

*Hoplopleura hesperomydis* (Osborn).

*Polyplax auricularis* K. & F. (Yosemite Nat. Park, Cali-  
fornia, U. S. A.).

*Peromyscus sitchensis prevostensis*.

*Polyplax auricularis* K. & F. (Forrester Is., Alaska).

*Onychomys leucogaster arcticeps*.

*Hoplopleura hesperomydis* (Osborn) (Colorado Springs,  
Colorado, U. S. A.).

*Polyplax auricularis* K. & F. (Colorado Springs, Colorado,  
U. S. A.).

*Onychomys torridus pulcher*.

*Hoplopleura hesperomydis* (Osborn) (Victorville, Califor-  
nia, U. S. A.).

*Polyplax auricularis* K. & F. (Victorville, California, U.  
S. A.).

*Sigmodon hispidus*.

*Hoplopleura hirsuta* Ferris (Raleigh, North Carolina, U.  
S. A.).

*Sigmodon hispidus texianus*.

*Hoplopleura hirsuta* Ferris (Lakeport, Texas, U. S. A.).

*Sigmodon hispidus eremicus*.

*Hoplopleura hispidus* Ferris (Sacaton, Arizona, U. S. A.).

## Muridæ of Uncertain Position

"Einer kleinen ratte mit sehr dicken, stachelartigen Haaren."

*Polyplax miacantha* Speiser (Salomona, Abyssinia).

"Gros Rats."

*Polyplax* ? *præcisa* Neumann (Abyssinia).

## Family DIPODIDÆ

*Dipus* sp.

*Eulinognathus aculeatus* (Neum.) (Tunis).

## Family PEDETIDÆ

*Pedetes caffer*.

*Eulinognathus denticulatus* Cumm. (South Africa).

## Family OCTODONTIDÆ

*Thryonomys swinderianus* (*Aulacodus swinderianus*).

*Scipio aulacodi* (Neum.) (Dahomey; Luangwa Valley,  
Northeastern Rhodesia, Africa).

*Thryonomys* sp.

*Scipio aulacodi* (Neum.) (Mfongosi, Zululand, South Africa).

*Scipio breviceps* Ferris (Mfongosi, Zululand, South Africa).

## Family CHINCHILLIDÆ

*Lagidium peruanum*.

*Hæmodipsus* ? *parvus* Kellogg & Ferris (Peru, South America).

## Order TUBULIDENTATA

## Family ORYCTEROPODIDÆ

*Orycteropus afer*.

*Hobophthirus notophallus* (Neum.) (South Africa)./

## Order PRIMATES

## Family LASIOPYGIDÆ

- Lasiopyga mona* (*Cercopithecus mona*).  
    *Pedicinus breviceps* Piaget.  
*Pithecus albibarbatus* (*Macacus silenus*).  
    *Pedicinus breviceps* Piaget (Zool. Mus. Hamburg).  
    *Pedicinus paralleliceps* Mjöberg (Zool. Mus. Hamburg).  
*Pithecus brevicaudus* or *P. rhesus* (*Macacus erythræus*).  
    *Phthirpedicinus piageti* (Stroebelt).  
*Pithecus nemestrinus* (*Inuus nemestrinus*).  
    *Pedicinus eurygaster* Gerv.  
*Pithecus rhesus* (*Macacus rhesus*).  
    *Pedicinus rhesi* Fahr.  
    *Phthirpedicinus micropilosus* Fahr.  
*Pithecus sinicus* (*Inuus sinicus*).  
    *Phthirpedicinus microps* (Nitzsch).  
*Pithecus irus* (*Cercopithecus cynomolgus*).  
    *Pedicinus longiceps* Piaget.  
*Pithecus fascicularis* (*Macacus cynomolgus*).  
    *Pedicinus eurygaster* Burm.  
*Pygathrix cristata* (*Semnopithecus prunosus*).  
    *Pedicinus longiceps* Piaget.  
*Pygathrix aurata* (*Trachypithecus maurus*).  
    *Hæmatopinus* (*Pedicinus* or *Phthirpedicinus*) ? *obtus*  
        Rudow.  
*Simia sylvanus* (*Inuus sylvanus*).  
    *Hæmatopinus* (*Pedicinus* or *Phthirpedicinus*) ? *albidus*  
        Rudow.

## Family CEBIDÆ

- Ateles ater* (*Ateles ater*).  
    *Pediculus capitis* De Geer.  
*Ateles paniscus* (*Ateles pentadactylus*).  
    *Pediculus consobrinus* Piaget.  
*Cebus fatuellus*.  
    *Pediculus capitis* (De Geer) (Rio de Janeiro, South America).  
*Cebus* sp.  
    *Pediculus capitis* (De Geer).

*Ateles pan* (*Ateles rellerosus*).

*Pediculus lobatus* Fahr. (Berlin Mus.).

Family HYLOBATIDÆ

*Hylobates concolor* (*Hylobates mülleri*).

*Pediculus oblongus* Fahr.

*Symphalangus syndactylus* (*Hylobates syndactylus*).

*Pediculus oblongus* Fahr.

Family PONGIDÆ

*Pan* sp. (*Simia troglodytes*).

*Pediculus schäffi* Fahr.

Family HOMINIDÆ

*Homo sapiens*.

*Pediculus capitis* De Geer.

*Pediculus corporis* De Geer.

*Phthirus pubis* Linnæus.

Primates of Uncertain Position

*Cercopithecus* sp.

*Pedicinus breviceps* Piaget (Zool. Mus. Hamburg).

*Ateles* ape?

*Pediculus mjöbergi* K. & F. (Traveling menagerie, Europe).

*Hamadryas* sp. (perhaps a *Papio*).

*Pedicinus hamadryas*.

Host entirely unknown but undoubtedly a Primate.

*Pedicinus* ? *graciliceps* Piaget.

Order ARTIODACTYLA

Family SUIDÆ

*Phachochoerus æthiopicus*.

*Hæmatopinus phachochoeri* End. (Nyasa Land, Africa).

*Phachochoerus oeliani massaicus*.

*Hæmatopinus phachochoeri* End. (Africa).

*Phachochoerus* sp.

*Hæmatopinus phachochoeri* End. (Africa).

*Potomochoerus affinis* nyasæ.

*Hæmatopinus phachochoeri* End. (German East Africa).

*Potomachoerus africanus*.

*Hæmatopinus phachochoeri* End. (Africa).

*Potomachoerus choerapotamus*.

*Hæmatopinus phachochoeri* End. (Zululand, South Africa).

*Sus scrofa domestica*.

*Hæmatopinus suis* L. (Cosmopolitan).

*Sus vittatus*.

*Hæmatopinus suis adventicius* Neum. (East Indies).

#### Family CAMELIDÆ

*Auchenia huanaca* (Llama).

*Linognathus prælongiceps* (Neum.) (South America).

*Camelus dromedarius*.

*Hæmatopinus tuberculatus* (Burm.) (Australia, imported from India).

*Camelus bactrianus*.

*Hæmatopinus tuberculatus* (Burm.)

African camels.

*Hæmatopinus tuberculatus* (Burm.) (Cairo, Egypt).

#### Family GIRAFFIDÆ

*Camelopardalis giraffa*.

*Linognathus brevicornis* (Giebel) (Africa).

#### Family CERVIDÆ

*Cervus elaphus*.

*Cervophthirius crassicornis* (Nitzsch) (Europe).

*Cervus unicolor*.

*Hæmatopinus longus* Neum. (Nepaul, India).

*Odocoileus columbianus*.

*Cervophthirius crassicornis* (Nitzsch) (Laytonville, California, U. S. A.).

*Rangifer tarandus*.

*Cervophthirius tarandi* Mjöb. (Sweden).

*Cearrus-Hirsch*.

? *Linognathus breviceps* (Piaget) (Guatemala).

## Family BOVIDÆ

## Subfamily CEPHALOPHINÆ

*Cephalophus maxwelli*.

*Linognathus breviceps* (Piaget).

*Cephalophus natalensis*.

*Linognathus angulatus* (Piaget) (Mfongosi, Zululand, S. Africa).

*Cephalophus nigrifrons*.

*Linognathus angulatus* (Piaget).

*Cephalophus* sp.

*Linognathus angulatus* (Piaget) (Zool. Mus. Hamburg).

## Subfamily CERVICAPRINÆ

*Cervicapra arundinum*.

*Linognathus fahrenheitzi* Paine (Nyassa Land, Africa).

*Cervicapra fulvorufula*.

*Linognathus fahrenheitzi* Paine (Mfongosi, Zululand, South Africa).

## Subfamily ANTILOPINÆ

*Antilope cervicapra*.

*Linognathus tibialis* var. *cervicaprae* (Lucas).

*Antilope euchore*.

*Linognathus tibialis* var. *euchore* Wat. (South African Museum, Cape Town).

*Antilope maori*.

*Linognathus tibialis* (Piaget) (Zoological Garden, Rotterdam).

*Antilope rupicaprae*.

*Linognathus stenopsis* (Burm.).

*Antilope* sp.

*Linognathus tibialis* var. *antennatus* (Piaget).

*Gazella subgutturosa* (*Antilope subgutturosa*).

*Linognathus tibialis* var. *appendiculatus* (Piaget) (Zoological Garden, Rotterdam).

*Gazelle*.

*Linognathus gazella* Mjöberg (Zool. Mus. Hamburg).

## Subfamily TRAGELAPHINÆ

*Taurotragus oryx*.

*Hæmatopinus taurotragi* Cumm. (Menagerie in England).

*Limnotragus gratus*.

*Linognathus limnotragi* Cumm. (Zool. Garden, London, from Congo).

## Subfamily RUPICAPRINÆ

*Rupicapra rupicapra* (Gemse).

*Linognathus rupicaprae* (Rudow) (Europe).

## Subfamily CAPRINÆ

*Capra ibex*.

*Linognathus forficulus* (Rudow) (Europe).

*Capra ægyptica* (Name does not appear in any lists, is possibly *C. ægagrus*).

*Linognathus stenopsis* (Burm.).

*Capra hircus*.

*Linognathus stenopsis* (Burm.).

"Mexican Goat."

*Linognathus stenopsis* (Burm.) (San Diego, California, U. S. A.).

*Ovis aries*.

*Linognathus ovillus* (Neum.) (Scotland and New Zealand).

*Linognathus pedalis* (Osborn) (Minnesota, Iowa, Nevada, U. S. A.).

Sheep.

*Linognathus stenopsis* (Burm.) (Abeokuta, Southern Nigeria, Africa).

## Subfamily BOVINÆ

*Bos taurus*.

*Hæmatopinus eurysternus* (Nitzsch) (Cosmopolitan).

*Linognathus vituli* (L.) (Cosmopolitan).

*Bos grunniens*.

*Hæmatopinus punctatus* Rudow.

*Bos caffer* (*Buffelus caffer*).

*Hæmatopinus bufali* (De Geer) (Africa).

*Bison bison*.

*Hæmatopinus tuberculatus* (Burm.) (North America).

"Common Buffalo."

*Hæmatopinus tuberculatus* (Burm.) (Vienna).

"Buffalo of India, Tonkin, Sumatra and Rumania."

*Hæmatopinus tuberculatus* (Burm.).

#### Order PERISSODACTYLA

*Equus caballus* (Domestic horse).

*Hæmatopinus asini* (L.) (Cosmopolitan).

*Equus asinus* (Ass).

*Hæmatopinus asini* (L.).

*Equus burchelli*.

*Hæmatopinus asini* (L.) (South Africa).

#### Order PROBOSCIDEA

##### Family ELEPHANTIDÆ

*Elephas indicus*.

*Hæmatomyzus elephantis* var. *sumatranus* Fahr. (Sumatra).

*Loxodonta africana* (*Elephas africanus*).

*Hæmatomyzus elephantis* Piaget.

#### Order HYRACOIDEA

##### Family PROCAVIDÆ

*Procavia capensis* (*Hyrax capensis*).

*Linognathus caviæ-capensis* (Pallas). (South Africa).

*Procavia syriaca* (*Hyrax syriacus*).

*Linognathus leptcephalus* (Ehrenb.) (Syria).

#### Host Unknown

*Hæmatopinus* (*Linognathus*) ? *squamulatus* Neum. (Diri-Daoua, Abyssinia).

## APPENDIX

Since the preceding pages were sent to press the author has received from Mr. Bruce Cummings, of the British Museum, and Mr. James Waterston, of the Imperial Bureau of Entomology, certain notes which are here appended. To both these gentlemen thanks are due.

The addition of these notes makes the Catalogue complete to April 1, 1916.

*Linognathus microcephalus* (Garnett). From domestic sheep (New Zealand).

NOTE: "This is in my opinion the same as *Linognathus pedalis* (Osb.)" (Waterston).

1915. *Hæmatopinus microcephalus* Garnett, Jour. Comp. Pathology and Therapeutics, pp. 2-3, 3 figs.

*Linognathus pithodes* Cummings. From *Antelope cervicapra* (Zool. Garden, London).

1916. *Linognathus pithodes* Cummings, Proc. Zool. Soc., London (March, 1916).

*Hoplopleura pectinata* (Cummings).

NOTE: "*Polyplax pectinata* Cum., is a *Hoplopleura*" (Cummings).

*Echinophthirius horridus* (Olfers).

1816. *Pediculus horridus* Olfers, De Vegetativis et Animalis.

NOTE: "*Echinophthirius phocæ* Lucas, equals *E. horridus* (Olfers)" (Cummings).

*Hoplopleura bidentata* (Neum.). From *Hydromys chrysogaster*; not from *Epimys rattus* (Harrison).

*Linognathus setosus* (Olfers).

1816. *Pediculus setosus* Olfers, De Vegetativis et Animalis.

NOTE: "*Linognathus piliferus* (Burm.) equals *Pediculus setosus* Olfers" (Harrison).

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PROCEEDINGS  
OF THE  
CALIFORNIA ACADEMY OF SCIENCES  
FOURTH SERIES

VOL. VI, No. 7, pp. 215-221

MAY 12, 1916

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VII

FOUR SPECIES OF SALAMANDERS NEW TO THE  
STATE OF CALIFORNIA, WITH A DESCRIPTION  
OF PLETHODON ELONGATUS, A NEW  
SPECIES, AND NOTES ON OTHER  
SALAMANDERS

BY

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In recent years the Academy has received specimens of four species of salamanders which seem never to have been collected previously in California. Three of these have been known from examples secured in Oregon or Washington; the fourth species appears never to have been described. In recording these facts opportunity is taken to publish certain other notes regarding California salamanders.

1. *Ambystoma macrodactylum* Baird.

Three specimens (Nos. 39656, 39657, 39658) collected by Dr. E. C. Van Dyke in July, 1915, near Fallen Leaf Lake, El Dorado County, California, add a species to the known fauna of the State. They seem to differ in no respect from others collected in Washington.

May 12, 1916

## 2. *Chondrotus paroticus* Baird.

I have not been able to find any previous record of the occurrence of this salamander in California. It is represented in our collection by a typical specimen (No. 29108) found by Mr. J. R. Slevin in wet earth under a stump near Requa, Del Norte County, California, May 22-26, 1911.

## 3. *Autodax ferreus* Cope.

This salamander has been known only from the type specimen (U. S. N. M. No. 6794) collected by Dr. Vollen at Fort Umpqua, Oregon. We have specimens from Elmira and Marshfield, Oregon, and from Bayne Island, British Columbia, as well as from Requa, Del Norte County; Alton, Trinidad, and Carlotta, Humboldt County; and Comptche, Mendocino County, California. Our two Requa examples (Nos. 29099 and 29102) were found by Mr. Slevin, May 22-26, 1911. They were taken from the rotten wood of a dead tree in which they were living some 20 feet above the ground. This species is related to *Autodax lugubris*, but is quite distinct.

## 4. *Plethodon elongatus*, new species.

*Diagnosis*—Similar in general appearance to *Plethodon vandykei* and *Plethodon intermedius*, but somewhat stouter; costal grooves 16; toes and fingers not webbed; adpressed limbs separated by 6 or 7 costal interspaces; tail cylindro-conic, considerably compressed in distal third; paratoid not developed; a dorsal band as in *P. intermedius*, but obscured by the general duskiness of coloration; lower surfaces blackish brown, relieved with whitish dots.

*Type*—Cal. Acad. Sci. No. 29096, Requa, Del Norte County, California, J. R. Slevin, May 22-26, 1911.

*Material*—Four specimens (Nos. 29094, 29095, 29096 and 29101) from Requa, all collected at the same time.

*Description of the type*—General form similar to *P. intermedius*, but with body, limbs and tail somewhat stouter; tail cylindro-conic, compressed laterally in posterior half, nearly equal to length of head and body, with strong vertical grooves

nearly to tip; head somewhat depressed, about width of widest part of body; snout rounded from above and in profile; eyes moderate, separated anteriorly by about one and one-half times the length of the orbital slit; nostrils small, separated by about their distance from pupil; subnasal groove descending nearly to margin of lip; line of lip curved downward from below eye to end of snout; palatine teeth in two slightly curved series beginning just behind the internal nares, converging obliquely backward, and separated on the median line by a space greater than the diameter of the internal nares; parasphenoid teeth in one patch throughout, separated from the palatine teeth by an interval equal to distance from nostril to edge of lip; internal nares small; tongue large, ovate, not emarginate, attached along median line but free laterally and, for a short distance, behind; neck a little narrower than body, no paratoid gland, gular fold continued up and then forward as a groove to eye; a groove along vertebral line from head to tail; costal grooves between limbs 16, not continued to midline either above or below; limbs a little stouter than in *P. intermedius*, and with shorter digits, anterior with four and posterior with five digits; digits rather short, with rounded ends, each with a small terminal pad, inner shortest, third longest, second finger longer than fourth, second toe shorter than fifth, third and fourth toes nearly equal, broadly palmate, but no web; adpressed limbs separated by about six costal folds.

The coloration is similar to that of *P. intermedius*, but heavily clouded with black. The general color is blackish brown above and below; a broad, lighter brown, black-edged, dorsal band extending from snout to base of tail; lower surfaces sprinkled with small whitish dots, which become larger on the sides, gular region and chin.

<i>Measurements</i>		MM.
Snout to anus.....		59
Front of anus to end of tail.....		58
Width of head.....		7.5
Nostril to orbit.....		1.5
Snout to orbit.....		3
Snout to gular fold.....		11
Snout to fore limb.....		14.5

Gular fold to anus.....	38
Axilla to groin.....	30
Adpressed limbs separated by.....	11
Fore limb .....	9
Hind limb .....	10.5
Heel to end of longest toe.....	5
Breadth of foot.....	3.5

*Variation*—The three adult specimens are identical in structural characters and coloration. No. 29101 is a young salamander measuring 28mm. from snout to anal opening, with a tail 14mm. long. It is like the three adults in the number of its costal folds and general coloration, except that the dorsal band is bright pink clouded on the head and along the mid-dorsal line with dark brown. This brightly colored band extends from the snout, along the back, nearly half way down the tail. This specimen looks very much like *P. intermedius*, but the lower surfaces are darker.

*Remarks*—While this new species is manifestly closely related to *Plethodon intermedius* and *P. vandykei*, it can easily be distinguished from both by the greater number of its costal grooves and the greater space between its adpressed limbs. The number of costal grooves is 16 in all four specimens of the new species, while in *Plethodon vandykei* these grooves are 12 and 13, and in *P. intermedius* they are 13 or 14. *Plethodon intermedius* is of more slender build, with longer toes, more truncate snout, and less dusky coloration. The paratoid gland and webbed feet of *P. vandykei* are characters which should render its recognition easy.

##### 5. *Plethodon intermedius* Baird.

This salamander was originally described from one specimen said to have been secured by John Xantus while stationed at Fort Tejon, California. So far as I know, with the exception of the type of *Plethodon crassulus*, this species has never since been found in California, although it is common in western Oregon and Washington. I have felt that the type could not have been collected by Xantus near Fort Tejon, but must have been so recorded through some error. With this

in mind I wrote to Dr. Stejneger to inquire whether the records of the National Museum would throw any light on the matter. He has very kindly investigated these records and writes that "there seems originally to have been some trouble with the series of entries to which these belong, as apparently by some mistake two collections were given the same numbers. The locality Ft. Tejon looks to me exceedingly dubious, though, of course, it does not mean only the immediate neighborhood of the old fort." A copy of the old record is printed here under that of *Plethodon croceater*; see remarks under head of that species.

Seventy specimens of *Plethodon intermedius* from Oregon and Washington show costal grooves as follows:

Specimens	Costal grooves
9 .....	13-13
3 .....	13-14
58 .....	14-14
—	
70	

#### 6. *Plethodon crassulus* Cope.

The question of the identity of this salamander was raised by the comparison of *Plethodon intermedius* and *Plethodon elongatus*. *Plethodon crassulus* was described in 1886 by Cope from one specimen in the U. S. National Museum, and was said to have been collected in California by Dr. J. G. Cooper. Cope says that "this species has a superficial resemblance to the *P. oregonensis*, but its manifold differences are easily perceived." He also states that the form is quite robust, but his cuts show a salamander similar in size and proportions to *P. intermedius*, and his description fits that species in every detail, for some specimens of *P. intermedius* show the dorsal band very indistinctly. The type of *P. crassulus* is No. 9447 of the National Museum collection. In response to my request for information regarding it Dr. Stejneger has very kindly written me as follows:

"The record of 9447 is dated November 20, 1877, is in an unknown hand, and is blank as far as name is concerned. Locality is given as California, collector as Dr. Cooper. You

ask what I think of *P. crassulus*. I have given the question some thought and I am of the opinion that it is a uniform color phase holding the same relation to *P. intermedius* (with which the type agrees structurally and not with *P. oregonensis*) as *P. cinereus* does to *P. erythronotus*."

*P. crassulus* may, therefore, be regarded as a synonym of *P. intermedius*. I think one is justified in doubting that the original specimen really was collected in California.

### 7. *Plethodon croceater* Cope.

This salamander also was described from a single specimen said to have been sent to the National Museum by John Xantus from Fort Tejon, California. This specimen was No. 4701 of the National collection. It seems to have been lost, for Dr. Stejneger writes me that it has not been on the shelves in his time. As in the case of *P. intermedius*, "there seems originally to have been some trouble with the series of entries to which these belong, as apparently by some mistake two collections were given the same numbers. First there is an entry in an unknown hand in black ink and under there is an entry in Prof. Baird's handwriting thus:

"4701 Rana	Chiloweyush	Dr. C. B. Kennerly
Heredea	Fort Tejon —1—	Xantus
" 4732 Scotophis gutatus	Micanopy, Fla.	Dr. Bean
"                   occidentalis	Ft. Tejon	Xantus

"The ditto mark [under *Scotophis*] refers to the line above, which is *Plethodon*, and this *Plethodon*, No. 4731, is a *Plethodon cinereus* from Detroit, Dr. Sager."

It is evident that the locality Ft. Tejon is "exceedingly dubious." *Plethodon occidentalis* is evidently a manuscript name for *P. intermedius*.

Cope has recorded *Plethodon croceater* from Cape San Lucas, Lower California, and San Diego, California, both of which localities need confirmation. The former locality may have resulted from the association of the original specimen with John Xantus, who collected both at Cape San Lucas and

Fort Tejon. The latter, probably refers to a specimen recorded by Mr. Lockington (Am. Nat. XIV, 1880, p. 295) as having been taken in Lower California 75 miles southeast of San Diego.

I have seen a number of specimens from the Sierra Nevada. The ground color varies from light brown to nearly black, and the yellow spots vary greatly in size and arrangement.

#### 8. *Plethodon flavipunctatus* Strauch.

I have no doubt that this is the same species as Cope's *Plethodon croceater*, with which the description agrees.

#### 9. *Triton ensatus* Eschscholtz.

Eschscholtz evidently had the species which Baird and Girard later described as *Amblystoma tenebrosus*, and which Cope referred to his genus *Chondrotus*. *Dicamptodon* Strauch is an older term than *Chondrotus*. Those who prefer to remove the species from the genus *Ambystoma* may use the name *Dicamptodon ensatus* (Eschscholtz).



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CALIFORNIA ACADEMY OF SCIENCES  
FOURTH SERIES

VOL. VI, Nos. 8 and 9, pp. 223-294, pls. 3-17. JUNE 23, 1917

VIII  
REPORT OF THE PRESIDENT OF THE ACADEMY  
FOR THE YEAR 1916

BY  
C. E. GRUNSKY  
*President of the Academy*

In view of the fact that the work of the California Academy of Sciences, its purposes and aims, were rather fully set forth in the various addresses delivered at the dedication of its Museum Building in Golden Gate Park last September, this annual report will be brief and devoted in the main to a summarization of such facts and events as seem worthy of special mention.

No special effort has been put forth during the last year to swell the Academy's membership list. The accession of new members has nevertheless a little more than offset the losses by death and resignation. The present membership in the Academy is 483, made up of:

Patrons .....	5
Honorary Members .....	26
Life Members .....	83
Members .....	369

During the year 1916 there was an accession of 33 new members, and the Academy lost by death 5, by resignation 11, and by being dropped for arrearages in dues 6; leaving a net gain in membership of 11.

June 23, 1917

The losses by death were:

Davis, Mr. Horace.....	Life Member .....	July 12, 1916
Gutzkow, Mr. Frederick.....	Life Member .....	May 7, 1916
Leszynsky, Mr. S. L.....	Member .....	March 8, 1916
Slater, Dr. Philip Lutley.....	Honorary Member .....	....., 1916
Trask, Mrs. Blanche .....	Life Member .....	Nov. 11, 1916

The Academy carries on its list of patrons the following names:

Alvord, William	Bourn, William B.
Crocker, Charles	Crocker, William H.
Hendrie, John W.	Dunne, Peter F.
Lick, James	Grant, Joseph D.
Hosmer, Mrs. Charlotte	Morrison, Alexander F.

Of these the last six are the surviving members. Two other public spirited citizens, Mr. Herbert Fleishhacker and Mr. A. King Macomber, have recently very generously offered to instal large habitat groups in the Museum, whereby they will become patrons.

#### LECTURES

During the year 1916, 11 free lectures have been delivered at the stated meetings of the Academy, as follows:

JANUARY 19.	"Bird and Animal Life of the Yosemite Region." Tracy I. Storer, Assistant Curator of Birds, Museum of Vertebrate Zoology, University of California.
MARCH 15.	"The Gulls in and about San Francisco." Joseph Mailliard.
APRIL 19.	"Bird Life as seen through a Camera." Dr. J. Rollin Slonaker, Professor of Physiology, Stanford University.
MAY 17.	"The Relation of our Salmon and Trout to Forest Conservation." N. B. Scofield, Expert in charge of the Department of Commercial Fisheries, California State Fish and Game Commission.
JUNE 21.	"Game Conditions in Great Britain vs. Conditions in California." Carl Westerfeld, California Fish and Game Commissioner.
JULY 19.	"Horticultural Quarantine." Frederick Maskew, Chief Deputy Quarantine Officer of the California State Horticultural Commission.
AUGUST 16.	"A Naturalist in the Bahama Islands." Dr. Charles Lincoln Edwards, Director of the Los Angeles Zoological Park and Aquarium.
SEPTEMBER 20.	"The Fur Seals and other animals of the Pribilof Islands." George A. Clark, Academic Secretary of Stanford University.
OCTOBER 18.	"The Physiographic History of the Southern Sierra and Mojave Desert Regions." Dr. John P. Buwalda, Instructor in Geography, University of California.

- NOVEMBER 15. "Japanese Pearl Fisheries."  
Prof. C. A. Kofoed, Department of Zoology, University of California.
- DECEMBER 20. "The California Pocket Gopher as a Useful Animal."  
Dr. Joseph Grinnell, Director of the Museum of Vertebrate Zoology, University of California.

In addition, Sunday afternoon lectures are being delivered in the Museum building, since October. The list for 1916 embraces the following:

- OCTOBER 22. "Picturesque India."  
Dr. Walter K. Fisher, Stanford University.
- OCTOBER 29. "To the Tip-top of the United States in Quest of the Golden Trout."  
Dr. Barton W. Evermann, Director of the Museum.
- NOVEMBER 5. "A Trip to the Southern Sierra Nevada and the Cañon of the Kern."  
Dr. Roy E. Dickerson, Assistant Curator of Paleontology.
- NOVEMBER 12. "The Argentine Ant; a Pest from South America."  
Prof. C. A. Woodworth, Department of Agriculture, University of California.
- NOVEMBER 19. "Ups and Downs of the Pacific Coast."  
Prof. R. S. Holway, Department of Geography, University of California.
- NOVEMBER 26. "Some Common California Mammals."  
Dr. Joseph Grinnell, Director of the Museum of Vertebrate Zoology, University of California.
- DECEMBER 3. "Injurious Insects."  
Prof. E. A. Essig, Department of Agriculture, University of California.
- DECEMBER 10. "Turtles of the Galapagos Islands."  
Dr. John Van Denburgh, Curator of the Department of Herpetology, California Academy of Sciences.

#### ACCESSIONS TO THE MUSEUM AND LIBRARY

Among the notable donations with which the Academy's collections of material and of books have been enriched during 1916, the following may be noted:

- Argentine Government, through Hon. Enrique M. Nelson, Commissioner-General, Panama-Pacific International Exposition: Thirty-nine specimens of mounted Argentine birds; eight mounted specimens of native mammals; 10 boxes of exhibits of native insects; 10 framed colored drawings of Argentine plants; one stereoscope and 37 slides; exhibit illustrating water filtration; specimens of Argentine plants.
- Branner, Dr. John C., Stanford University: 55 bound volumes.
- California Botanical Club, through Miss Alice Eastwood: A collection of 397 specimens of Mexican plants collected by Dr. Edward Palmer in 1910, purchased for \$39.80 by the Club.
- Crocker, Mr. William H.: Three large folios, "Japanese Temples and their Treasures."

- Evermann, Dr. Barton W.: Ten manganese nodules dredged by the U. S. Fish Commission Steamer Albatross in the South Pacific during the Agassiz-Albatross South Pacific Expedition of 1899-1900, and a collection of garnets from St. George Island, Pribilof Group.
- Grant, Mr. J. D.: One buffalo skull from the Klamath River.
- Heyer, Mrs. H. C., San Francisco: Sixty-one specimens of Alaska birds, chiefly water birds.
- Kelly, Mr. James H., Tiburon, Cal.: Twenty-one numbers of the earlier publications of the Academy.
- Logan, Mr. Hugh B. Baker, Ore., through Mr. John W. Mailliard: One skin of the Mountain Coyote (*Canis latrans lestes*), male, from North Powder, Baker Co., Oregon, and one skin of the Pallid Barred Wildcat (*Lynx fasciatus pallascens*), male, from Salisbury, Baker Co., Oregon, both collected by the donor.
- Martin, Mr. Bruce: 627 insects collected in Colombia, South America, including some very interesting forms.
- Mailliard, Mr. John W.: Two specimens of the California Condor (*Gymnogyps californianus*), collected in San Diego Co., California, by E. B. Towne.
- Merriam, Dr. C. Hart, Washington, D. C.: A collection of 486 specimens of Atlantic coast mosses, comprising 65 genera and 181 species, all new to the herbarium.
- Smith, Mr. L. E., Sisson, Cal.: One hundred and forty-nine bound volumes.
- Snodgrass, Mr. R. E.: Seventeen volumes and 13 pamphlets, concerning the Galapagos Islands.
- Tobin, Mr. J. S.: Cash donation, \$250.
- U. S. Fisheries Steamer "Albatross": Twenty-one bird skins; 181 jars, vials and bottles of specimens of fishes, sponges, molluscs, crustaceans, etc.

## PUBLICATIONS

The Academy has published during 1916 the following papers in continuation of the Fourth Series of the Proceedings:

- Vol. V, No. 7, pp. 195-201  
REPORT OF THE PRESIDENT OF THE ACADEMY FOR THE YEAR 1915  
by C. E. Grunsky, President of the Academy.
- Vol. V, No. 8, pp. 202-223  
REPORT OF THE DIRECTOR OF THE MUSEUM FOR THE YEAR 1915  
by Barton Warren Evermann, Director of the Museum.
- Vol. VI, No. 1, pp. 1-17  
EOCENE OF LOWER COWLITZ RIVER VALLEY, WASHINGTON  
by Charles E. Weaver.
- Vol. VI, No. 2, pp. 19-40  
THE POST-EOCENE FORMATIONS OF WESTERN WASHINGTON  
by Charles E. Weaver.
- Vol. VI, No. 3, pp. 41-52  
THE OLIGOCENE OF KITSAP COUNTY, WASHINGTON  
by Charles E. Weaver.
- Vol. VI, No. 4, pp. 53-85  
THE PACIFIC COAST RACES OF THE BEWICK WREN  
by Harry S. Swarth.
- Vol. VI, No. 5, pp. 87-128  
MONOGRAPH OF THE NORTH AMERICAN SPECIES OF ORTHOTYLUS (HEMIP-  
TERA)  
by Edward P. Van Duzee.

Vol. VI, No. 6, pp. 129-213

A CATALOGUE AND HOST LIST OF THE ANOPLURA  
by G. F. Ferris.

Vol. VI, No. 7, pp. 215-221

FOUR SPECIES OF SALAMANDERS NEW TO THE STATE OF CALIFORNIA, WITH  
A DESCRIPTION OF PLETHODON ELONGATUS, A NEW SPECIES, AND NOTES  
ON OTHER SALAMANDERS.  
by John Van Denburgh.

Title pages and Indices for Fourth Series, Proceedings, Volumes IV and V, have also been printed but have not yet been distributed.

The notable event in the affairs of the Academy which marks the beginning of a new epoch in its history, was the dedication on September 22, 1916, of the new Museum building in Golden Gate Park, with a first view by members and their friends of the habitat groups of which, at that time, 11 principal groups and a number of lesser groups had been completed. The exercises on that occasion have been made a matter of record and I desire at this time only to renew the assurance to those who have made so much accomplishment possible of the sincere appreciation by all members of the Academy of the generosity and good will which has found such happy expression in this building and its contents.

Of the 11 principal groups the three bird groups were made possible by special donations as follows:

The Farallon Bird Group, by Mr. Wm. H. Crocker.

The San Joaquin Valley Bird Group, by Mr. Jos. D. Grant.

The Desert Bird Group, by Mr. Wm. B. Bourn.

I may note in connection with the installation of habitat groups that the Academy no longer commands the services of Mr. John Rowley, under whose supervision the habitat groups have been installed. Mr. Rowley has gone to the Municipal Museum of Oakland.

I cannot refrain from commending again the results of Mr. Rowley's work. The groups which have been installed portray nature, and especially the various animals therein presented, with remarkable fidelity. The general arrangement and effect of each group is pleasing and all will bear the closest inspection.

The fact that Mr. Rowley will be active in such close proximity to San Francisco as Oakland, prompts the hope that for special work as occasion arises his services will still be available.

The Academy has been fortunate in securing the services of Mr. E. P. Van Duzee as Curator in the Department of Entomology and as active Librarian. The proper housing of the Library and the attention which it is now receiving have added greatly to its usefulness.

In the other departments of the Academy's work there has been no material change.

What has been done in these various departments will be set forth by the several curators and it would be but repetition to dwell upon their activities in this general statement of affairs.

The Director of the Museum, Dr. Evermann, will report in some detail upon the Museum and research work which has been accomplished and of the cordial appreciation which the public is manifesting in the Academy's work.

In order to make possible what has thus far been done on and in the museum building, the Academy has had to live beyond its income for several years. It has been necessary to add to our indebtedness about \$35,000. This is not a serious matter but is cited as an evidence of the efforts of your Trustees and Officers to make the collected scientific material available for examination and study at the earliest possible date.

The estimated assets of the Academy are about \$1,400,000, mainly represented by the Market Street property, against which there are liabilities of about \$336,000. The net annual income may be stated in round numbers at about \$50,000. It is expected that of this amount about \$10,000 per annum can during the next few years be held available for reducing our financial obligations.

There is not yet any prospect for the enlargement of the museum building, which would only be possible by outside aid. The space which has thus far been made available is, of course, inadequate to meet prospective requirements. All friends of the Academy should, therefore, as opportunity offers, call the attention of those who are financially able, to the good work which an ample additional endowment would make possible.

In closing, I desire to express on behalf of the officers of the Academy their appreciation of the interest manifested by the members, and desire also to extend my personal thanks to the officers and members for their cordial support and also to the employees who have so willingly made sacrifices in the interest of the Academy whenever called upon to do so.

## IX

### REPORT OF THE DIRECTOR OF THE MUSEUM FOR THE YEAR 1916

BY

BARTON WARREN EVERMANN

*Director of the Museum*

At the time of the last annual report of the Director of the Museum (February 16, 1916), the actual installation of the habitat groups of California mammals and birds was well under way.

Besides the regular employees of the Division of Exhibits, who devoted all their time to the habitat groups, three extra temporary men were employed on that work for nearly a year. By the twenty-first of September the following groups had been completed:

California Valley Elk, Black-tail Deer (summer group), Northern Mule Deer (winter group), Antelope, Desert Mountain Sheep, Mountain Lion, Black Bear, Leopard Seal, California Sea Lion, Steller's Sea Lion, Raccoon and Striped Skunk, Coyote, Farallon Islands Bird Rookery, San Joaquin Valley Spring Bird Group, and Desert Bird Group. Opportunity has been taken to reproduce in this report excellent photographic illustrations of a number of these habitat groups.

In addition to these 15 groups the California Condor Group was complete with the exception of the birds, which will be secured later. Small groups of the California Valley Quail and the Western Meadowlark were also completed.

It was felt that the time had arrived for the dedication of the Museum building and the opening of the Museum to the public. The formal dedicatory exercises were held on Friday afternoon, September 22, in the California mammal room of the Museum.

Mr. C. E. Grunsky, the President of the Academy, presided.<sup>1</sup> The invocation was by the Right Reverend William Ford Nichols, bishop of California. Brief addresses were

<sup>1</sup>A report of the opening exercises was published in *Science* for October 27, 1916, pp. 598-603.

made by the following: Mr. William H. Crocker, President of the Board of Trustees; Mr. C. E. Grunsky, President of the Academy; Mr. Edward Rainey, for the Mayor; Mr. George Haviland Barron, Curator of the Memorial Museum, San Francisco, for the Board of Park Commissioners; Dr. David Starr Jordan, Chancellor Emeritus, Stanford University; Dr. Barton Warren Evermann, Director of the Museum.

Mr. Crocker spoke feelingly of his long connection with the Academy, as President of the Board of Trustees continuously since 1898, or 18 years. Before him his brother, Charles F. Crocker, had occupied the same position for a number of years and his father, Charles Crocker, was deeply interested in the Academy.

As president of the Board of Trustees, Mr. Crocker formally dedicated the new Museum building to the advancement of the biological and physical sciences and the educational interests of the city of San Francisco and the state of California. He then turned the building over to the Academy.

Speaking of the history and the aims and ambitions of the Academy, President Grunsky said, in part:

Organized in 1853, the California Academy of Sciences has now for 63 years been conducted along broad lines for public service. Membership in the Academy at a nominal annual fee is open to all who are interested in the study or advancement of science. Its activities are directed mainly along educational lines in providing the material and opportunity for securing information on matters pertaining to the natural sciences; and second, along lines of research and study in the various subdivisions of the natural sciences.

There are those present today who will recall, and some who were active in, the activities of the Academy while it was quartered in a building at the southwest corner of California and Dupont streets, and there are many here who have enjoyed and who have profited by the natural history museum and its accessories maintained for many years prior to the great disaster of 1906 on Market between Fourth and Fifth streets.

It would be needless to present at this time a review of the history of the Academy and of the work done by it. Those who desire will find much of interest and of value in the published records of the Academy's Proceedings.

It would be futile to give a due meed of credit to those heretofore connected with the work of the Academy whose contributions have borne fruit, and whose achievement is expressed in some measure in the Museum plant now to be brought closer to the general public. It must suffice to say that at all times in the history of the Academy there was a group of

enthusiastic scientific workers—with changing personnel—who stood ever ready to make, and did make, the sacrifices and put forth the personal effort which made the work of the Academy worth while.

In the matter of publications, as in the case of its other activities, the Academy has had to accept the limitation upon its output made necessary by the lack of adequate funds. Much has been left undone which ought to be done. Time will not, however, permit me to take up this matter for full presentation. Let me call attention merely to one fact which will be patent to all who look carefully into the affairs of the Academy. The field in which the Academy is active is but imperfectly covered; nor can it be covered as it should be without adequate support from those of means who, in furthering the aims of the Academy, will not alone be benefiting our city and commonwealth, but will be contributing to the sum of human knowledge.

The building which has here been erected and is today being dedicated is located upon public ground. The Academy has invested in it \$183,000. Yet this building, while it is an earnest of what the Academy is willing to do for the public, represents, in area occupied, only about one-third of that of the museum building which we hope some day in the near future will be completed on this site.

To accomplish the incomplete work with which we desire you to become better acquainted, the Academy has taxed its resources as far as seemed wise and has made it possible to open to the public, housed in the first unit of its museum building, certain exhibits which will forecast what it is hoped may ultimately be adequately accomplished. There should be here assembled material from the Pacific Ocean and its shores representative of all the natural sciences, more complete than can be found elsewhere. It can be done and will be done, but not without outside aid. The resources of the Academy, chiefly the result of bequests and endowments that will be referred to later, are limited and our installations and facilities for housing material always obtainable in abundance must progress slowly unless the Academy can count on the generous assistance of those who have the means.

We can not at this time announce when our building will be extended. More material for research and exhibition has already been collected than we can properly display. Some of the most striking habitat groups that should be at once installed must wait until more funds are provided and in some cases until the time has come when we can add to the building.

It has been suggested that the Academy should extend its activities by assuming the management of an aquarium. I think I speak for every member when I say that the Academy is ready to do this. But even though there are those of our citizens who may be willing to erect and equip the necessary buildings the Academy is not so circumstanced that it can provide the funds for maintenance and operation. But its staff and its organization including the services of its Director of the Museum, Dr. Evermann, an expert in matters relating to fishes and the fisheries, are ready to help and will help. San Francisco should have an aquarium filled with

the life of the Pacific Ocean and of the streams discharging into the ocean, second to no other aquarium in the world.

The Academy has asked you to be present today at this dedication of the first unit of its museum building in order that you may become better acquainted with the Academy's aims and purposes and as a reminder to the public that the Academy is here to benefit and serve the whole community.

It is appropriate that at this time attention be called to the generous aid which the Academy has received in the past and to that which it is now receiving in its plans for an enlarged field of usefulness.

It should be remembered that the Academy is in Golden Gate Park with the consent of the people of San Francisco, who have seen fit to increase the Academy's opportunity for service by permitting the erection here of the necessary museum buildings. This consent was given in 1910 and ever since that time the plans have been under consideration and in execution which are today beginning to see fulfillment.

By bequest of James Lick forty-one years ago, the Academy became the owner of the Market Street property between Fourth and Fifth streets on which for many years a museum of natural history was maintained. This property, now in use for business purposes, is the Academy's present main source of income. The Lick bequest is now carried on the books as an asset of \$802,000.

In 1881 the Academy received from Mr. Charles Crocker an endowment of \$20,000, the income from which is to be used in aid of scientific research.

Mr. John W. Hendrie in 1899 bequeathed to the Academy the sum of \$10,000, the income from which has been set apart for the publication of scientific papers.

The late William Alvord bequeathed to the Academy the sum of \$5,000, to be used in improving and adding to its herbarium.

During the last decade, while husbanding its resources, and collecting the material which is now assembled in the building being dedicated today, the Academy affairs have necessarily received but little publicity and there has been but little opportunity for the public to become acquainted with its activities; nevertheless, the Academy has been selected by many who have collected material of scientific value as the proper institution to preserve the same and make it available for the public. Attention will be called to only a few recent donations the announcement of which is appropriate on this occasion.

Our generous public-spirited fellow citizen, William M. Fitzhugh, has, by purchase and additions thereto, preserved in its entirety the collection of Indian baskets, ornaments, implements and related material made in their lifetime by the late Professor and Mrs. T. S. C. Lowe, of Pasadena. This collection of exceptional interest and magnitude, which would otherwise have been scattered and would have lost value by piecemeal sale, is on display in the Academy Museum as a loan and merits your careful attention.

The most important gift which the Academy has recently received is that of the Henry Hemphill collection of marine, freshwater and land shells. This magnificent collection, the making of which engaged the attention of

Mr. Hemphill during practically all the years of his long and useful life, and which contains between 60,000 and 70,000 specimens representing more than 12,000 species, has been donated to the Academy by Mrs. Charlotte Hosmer, daughter of Mr. Hemphill. The Academy feels grateful to Mrs. Hosmer for this most generous gift.

The installation of the bird-habitat groups which are today being opened to your inspection and which will contribute much to the education and enjoyment of the public has been made possible by the liberality of three other San Franciscans as follows:

Mr. Wm. H. Crocker has presented to the Academy the Farallon Islands bird group.

Mr. J. D. Grant has presented to the Academy the San Joaquin Valley bird group.

Mr. W. B. Bourn has presented to the Academy the Desert bird group.

It is their wish, as it is the wish of every one in any way connected with Academy activities, that these exhibits, and the others, now to be opened to public view, may prove instructive and inspiring and a source of lasting enjoyment to all of those who care to avail themselves of the privilege, open to all, of visiting the museum.

To these donors and to all who have contributed to the service value of the Academy, the Academy, through its President, expresses its sincere appreciation and gratitude.

The Academy welcomes such aid in the accomplishment of its aims and will ever be ready to accept and manage any trust having in view the advancement of science.

Mr. Rainey, representing the Mayor, and Mr. Barron on behalf of the Board of Park Commissioners, spoke of the great benefit which the Museum of the California Academy of Sciences will be to the people of San Francisco. The location of the Museum in Golden Gate Park, the most beautiful "people's playground" in the world, is a guarantee that it will be visited not only by our own people, but by all who come to San Francisco.

Dr. Jordan spoke of the value to general education and to science of natural-history museums. He called attention to the eminent position already attained in the field of scientific research by the California Academy of Sciences, and the prominent place the Academy is destined to fill as a scientific educational institution.

In a reminiscent way, he told of his many years' connection with the Academy, as President in 1896 and 1897, and again in 1900 to 1902, of his first visit to the Academy in 1879, and his pleasant meeting at that time with W. G. W. Harford and Dr.

Albert Kellogg the botanist and one of the founders of the Academy.

Dr. Evermann spoke in part as follows:

In the few minutes allotted to me I shall be able to speak briefly of only one or two of the museum's activities and aims.

The California Academy of Sciences is a scientific, educational institution. As a scientific, educational institution, the Academy, through its museum, has two important functions. The first of these is that of *scientific research*. The museum must furnish men and materials and facilities for scientific investigation. Through its research collections and its field investigations, it must study and solve its share of the multitude of scientific and economic problems which the physical and biological sciences present to us, particularly those presented by the zoology, botany and geology of western America and the broad Pacific. We must do our share in studying and investigating and making known the natural resources of our country. The Academy must contribute its share to the world's contributions to human knowledge.

The second important function of the Academy is *educational*. The Academy must do what it can within its means to be of real service in an educational way, not only to the general public, but also to the public and private schools.

One of the ways in which it is endeavoring to render educational service is by installing in this museum habitat groups of California mammals and birds and other exhibits that possess real educational value and which show the natural resources of the state.

Scientific research requires money and men. Habitat groups such as we are able to show you today also cost money.

The income of the Academy is limited; it is not sufficient to enable the museum to carry on the scientific work which it should do and also build up popular educational exhibits.

We have been able to prepare the splendid exhibits which we have to show you today because of the generosity of a number of public-spirited citizens of San Francisco and by curtailing somewhat for the time being the scientific activities of the Academy. Without the help of these friends of the Academy the valuable and attractive exhibits we have now installed would have been fewer in number. Nor would there have been so many if we had not drawn upon the Academy's funds for scientific research.

We have planned for several additional large habitat groups. We even have the animals on hand for a number of them. I may mention the very interesting elephant seal, a remarkable species of large marine mammal now nearly extinct. We have the animals for the group, but need funds for installing them. We have also the animals for two or three deer groups, a gigantic tortoise group, and a large iguana group. We have planned also for 22 groups of small California mammals, a dozen small bird groups similar to the very beautiful California quail group which you will see in the bird hall, and an indefinite number of small portable habitat groups such as that of the western meadowlark, which may be seen in the

office upstairs. These we propose to loan to the public schools should they desire them.

It is hoped that the necessary funds for these exhibits may be supplied by private donations, so that the net regular income of the Academy may be reserved chiefly for scientific research. The large groups cost from \$3,000 to \$4,000; the small groups about \$500 each; and the portable educational groups about \$100 to \$250 each.

It is hoped that this opportunity to do something worth while may appeal to those who are interested in education and who have the means to help along in such excellent work. What a splendid thing it would be for San Francisco and the state if, among those present here today, there might be some so impressed with the opportunity to help in this good work that they would provide the means to enable the Academy to add a dozen or more groups to the excellent series so well begun. We have the expert taxidermists and preparators to do the work; we need only the funds to meet the expense.

In conclusion, may I be permitted to mention one other need of the museum, to which I have called attention on another occasion.

It is my ambition that there shall be in this museum a *Children's Room*—a room in which will be displayed natural history objects such as are particularly attractive to little children. There would be in this room brightly and curiously colored birds and butterflies, moths and beetles and other insects; curious animals of other groups; attractive minerals, growing plants, and aquariums with interesting and instructive animal and plant life; colored transparencies of beautiful native flowers, all selected and arranged with reference to the telling of an interesting story, of teaching a definite lesson.

And there will be in this children's room a children's reading room in which will be found a library of all the interesting and reliable nature books and helps to nature study.

And there will be in charge of this children's room a well-educated, kindly, sympathetic man or woman who knows animals and plants; who knows the specimens in the museum and the live things in the park about it; and who, above all, knows and loves children; a man or woman who can wisely direct the observation and the reading of the children so that they may correlate their reading with what they have seen in the museum or in the open, and thus increase rather than stifle their interest in, and love for, animate things, as our public schools almost invariably do. It will be arranged so that children of the different grades will come to this room at different hours, and receive the instruction and help and encouragement adapted to their respective needs.

And all this will be done and done soon, I confidently believe. It will be done because it so evidently appeals to us all as being the *right thing to do*, the right sort of education and training to give our children. It will be done, because the beauty and worth of it all, for the little children's sake, will appeal to some one who has prospered in this world; some one with a kindly heart, who loves children, and who wants to help them to become the men and women they should become; and some day that man

or woman will come forward—I wish it might be today—and, out of his abundance, endow a *Children's Room* in this museum, and thus make it possible for the California Academy of Sciences to do this splendid work for the children of California, not only of today but for those of the years to come.

At the close of the formal dedicatory exercises a private view of the exhibits thus far installed was afforded the museum's guests, of whom nearly one thousand were present in response to the special invitation.

#### MUSEUM HOURS

The Museum has been open to the public every day since the formal opening, September 22, 1916. The hours for the public are from 10 A. M. to 4 P. M. on week days and from 10 A. M. to 5 P. M. on holidays, including Sundays.

#### VISITORS AT THE MUSEUM

Attendance at the Museum has been very satisfactory. The number of daily visitors has varied on week days from fewer than one hundred on rainy, stormy days to more than 2,200, and on Sundays from 1,600 to 10,000.

Totals by months are as follows:

September (9 days) .....	16,448
October .....	36,933
November .....	27,718
December .....	15,002
January .....	23,170

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Total to February 1, 1917.....119,271

#### THE MUSEUM AND THE SCHOOLS

One very gratifying feature is the interest which the public and private schools are taking in the Museum. A large number of teachers have brought their entire schools to the Museum. Whenever possible the Director has accompanied the school about the halls, explaining briefly to the children the various exhibits. When the time of the school would permit the chil-

dren were taken into the auditorium where an illustrated talk or lesson on some one of the habitat groups or other exhibits was given them.

These efforts to help the children to understand the exhibits, to show to the teachers and pupils that the exhibits in the Museum are available as illustrative materials for their regular school work, and to make the Museum of real educational value to them, are appreciated not only by the teachers but by the children as well.

The Academy is glad to be of service to the schools in this and all other ways in its power. It is hoped that even closer affiliation may be brought about and that a definite system for school visits may be arranged in the near future.

#### LECTURES

The regular course of free popular lectures on scientific subjects has been maintained throughout the year. These have been given at 8 o'clock on the third Wednesday evening of each month.

Soon after the formal opening of the Museum arrangements were made for a Sunday afternoon course of lectures. These have been given in the Auditorium of the Museum and have proved very popular, the attendance at each reaching in nearly every case the full capacity of the hall. Indeed, on a number of occasions, many people were turned away.

The lectures and the subjects are fully set forth in President Grunsky's report.

Through the liberality of Messrs. Wm. H. Crocker, R. J. Taussig, and John W. Mailliard the Academy has recently secured a complete moving picture equipment, including an excellent camera. It is the intention to secure a number of reels illustrative of wild animal life, particularly of the species shown in the Museum's habitat groups.

The success of the Sunday afternoon lecture course is due in large measure to the industry and resourcefulness of Messrs. Roy E. Dickerson, W. W. Sargeant, and Edward P. Van Duzee, to whom, as a committee, all lecture matters were assigned by the Director.

## EMPLOYEES

The regular employees of the Museum during the year 1916 have been as follows:

Director and Executive Curator, Dr. Barton Warren Evermann; Curator, Department of Botany, Miss Alice Eastwood; Curator, Department of Entomology, E. P. Van Duzee; Curator, Department of Herpetology, Dr. John Van Denburgh; Assistant Curator, Joseph R. Slevin; Acting Curator, Department of Mammals, John Rowley; Curator, Department of Invertebrate Zoology, Dr. Walter K. Fisher; Chief, Department of Exhibits, John Rowley; Assistants, Arthur L. Bolton, Paul J. Fair, Joseph P. Herring, and Mrs. M. L. Pariser; Assistant Curator, Department of Invertebrate Paleontology, Dr. Roy E. Dickerson; Librarian, Dr. Joseph Grinnell; Assistant Librarian, E. P. Van Duzee; Secretary, W. W. Sargeant; Stenographer and Typewriter, Miss Susie Peers; General Office Assistant, Ignatius W. McGuire; General Museum Assistant, John I. Carlson; Janitor, James H. Chastain; Assistant, Wm. C. Lewis; Janitress, Mrs. Johanna E. Wilkens; Night Watchman, Frank W. Yale; Day Watch, Patrick J. O'Brien.

## DEPARTMENT ACTIVITIES

The installation of the research collections of the respective departments having been practically completed before the beginning of the calendar year 1916, the curators and their assistants have been able to devote most of their time to field work for the securing of new material and to the care and study of the collections. The condition and activities of the various departments are set forth in detail in the reports of the respective curators and need be referred to here only briefly.

*Department of Botany.*—The customary enthusiasm and devoted industry have characterized the department of botany during the year. The mounting and labeling of specimens has engaged much of the time of the curator. In this work she has been materially assisted by the members of the Botanical Club, with whose help the herbarium has been put in excellent condition. Among the members of the Club who have rendered especially valuable service should be mentioned Mrs. Marian L.

Campbell, Mrs. G. Earle Kelly, Mrs. C. L. Pitcher, Mrs. Ernest Meiere, Miss Kate L. Stoney and Miss Lena Gibbs.

Many additions to the herbarium have been made within the year, the most important being a collection of 486 specimens of mosses donated by Dr. C. Hart Merriam; 81 specimens received in exchange from the U. S. National Museum; 100 plants from the Alps presented by Mrs. Zelia Nuttall; and two collections presented by the Botanical Club.

The Curator reports that the needed data for the proper labeling of the plants collected by the Academy's Galapagos expedition have at last been supplied by the collector and it is now possible to correlate the field numbers with those used in the published report.

The Botanical Club, under the supervision of the curator continues to hold weekly meetings and to be active in promoting interest in botanical matters.

The curator has maintained throughout the year in the vestibule of the Museum an exhibit of the flowers of the Park and country. This exhibit receives much attention from Museum visitors and is proving of great educational value.

*Department of Entomology.*—Mr. Edward P. Van Duzee, who entered upon his duties as Curator of Entomology on June first, has been indefatigable in enlarging the collections in his department, classifying, arranging, and labeling the specimens, and, in general, in making the rich material under his care available for study. During the year he made a number of short collecting trips which resulted in the addition of many valuable specimens. The total number of accessions to the department within the year is 4859.

Certain collections of the department have been sent to specialists for identification and study. The most important of these are the Orthoptera of the Galapagos expedition, sent to Messrs. Hebard and Rehn of Chestnut Hill, Pa., and the Plusiini sent to Dr. F. Ottolengui of New York.

Considerable time has been given by the curator to the determination of specimens submitted by correspondents and others who understand that the Academy is only too glad to be of service in this way.

The curator is putting through the press a synoptic catalogue of the Hemiptera of America north of Mexico, which will prove

one of the most voluminous and important contributions of the year to entomological literature.

*Department of Exhibits.*—The employees of this department were engaged during the entire year on the installation of habitat groups. As stated elsewhere in this report, 17 groups were completed by September 21. Since that date two other small groups have been partially completed. Certain other exhibits have been temporarily placed in the mammal hall. The principal of these are eight cases of commercial mollusks and crustaceans and a giant clam shell, received from the United States Bureau of Fisheries; eight cases of shells from the Hemphill collection, selected for their educational value and general interest; one case of the edible clams of the west coast of America, presented by Mr. and Mrs. T. S. Oldroyd; one case of minerals, one of fossil fishes, and one of California butterflies.

A very instructive exhibit contributed by the Standard Oil Company has been temporarily installed in the Bird hall. This exhibit, installed without expense to the Academy, is illustrative of the oil industry and attracts much attention.

All these exhibits which do not logically belong in the Mammal and Bird halls will be removed to appropriate exhibition rooms as soon as an additional wing is provided.

*Department of Herpetology.*—The activities of this department have continued throughout the year with their usual efficiency. Commendable progress has been made in classifying and arranging the collections on the shelves in the stack rooms. This work involves the separation, identification, re-bottling, labeling, and card-cataloguing of the entire collection, a task now more than one-third done.

During the year the collection was enlarged by the addition of 1536 specimens.

Considerable field work was done by the assistant curator in Nevada, Utah and Idaho, resulting in valuable collections and a much more complete knowledge of the herpetological fauna of those states.

The collections of this department now number 33,816 specimens, and are among the most extensive in America. The hope of the curator to make the department second to none in

America in completeness and value of material is an ambition which should receive the hearty support of the Academy.

Within the year the department has contributed four papers setting forth results of studies by the curator and assistant curator of the collections of the Academy, two of which have been published. The other two will be printed soon. Other scientific papers are in course of preparation.

*Department of Invertebrate Palontology.*—Mr. F. M. Anderson, the curator of this department, was on leave during the entire year, engaged on special work for certain oil companies and the Southern Pacific Railroad. The assistant curator, Dr. Roy E. Dickerson, has shown his accustomed energy and industry in looking after the interests of his department. A large amount was accomplished in preparing, sorting, identifying, and classifying the material in various collections, and putting the general collections of the department in order.

Although the budget allotment to the department was small several field expeditions were successfully conducted,—one to the Simi hills in Ventura and Los Angeles counties, one to the Marysville Buttes, one to the vicinity of Petaluma and Free-stone, and one in the area on the southern border of the Mohave Desert, where certain studies in historical geology were made in co-operation with Dr. L. F. Noble of the U. S. Geological Survey.

The assistant curator has been active and productive in original research, and has within the year contributed a number of papers to paleontological literature.

*Department of Invertebrate Zoology.*—In this department, which is as yet only in the formative stage, the work of the year has consisted almost exclusively in the making of collections for the department. The curator spent a portion of the month of June at Monterey Bay and vicinity collecting desirable material. In the same month some collecting was done in the vicinity of Point Conception.

In co-operation with the Department of Biology of the University of Southern California, two weeks were devoted to dredging about Santa Catalina Island.

The collections of the department have also been enriched by a valuable series of west coast Gephyrean worms and a mis-

cellaneous lot of invertebrates from British Columbia and the coast of California secured from Mr. W. F. Thompson, a small collection of California echinoderms donated by the University of Southern California, a representative series of invertebrates collected in the vicinity of Hilo, Hawaii, by Miss Leslie Tulloch, and a small lot of echinoderms from Boundary Bay, B. C., contributed by Prof. Frank W. Weymouth.

*Department of Mammalogy.*—As in the previous year the acting curator and his assistants devoted their time to the installation of habitat groups. Little or no time was given to enlarging the collections.

As no catalogue of the specimens in this department had ever been prepared, a proper record book was ordered made, and the collection was catalogued by Mr. Rowley, assisted by Mr. Bolton and Mr. Fair.

The total number of entries is 2300. Very few of the specimens in this department have been accurately identified. There is urgent need of a mammalogist competent to make the identifications and who can add to the collection so that it may become a fair representation of the California mammalian fauna.

*Department of Ornithology.*—This department being temporarily without a curator, has done no field collecting in the past year. The only additions to the collections are a few specimens received from miscellaneous sources. Mr. L. M. Loomis has continued to make use of the Tubinares of the collection in connection with the preparation of a monograph upon that group of birds upon which he is engaged.

*Library.*—Mr. Edward P. Van Duzee, who entered upon his duties as assistant librarian June first, came to us with long experience in library work. He had been connected with the Grosvenor Library of Buffalo, N. Y., for 28 years, 10 years as assistant librarian and 18 years as librarian. Although Mr. Van Duzee's primary duties are those of curator of Entomology, he nevertheless devotes a portion of his time to the library. With the assistance of Mr. Ignatius W. McGuire and Mr. John I. Carlson commendable progress has been made in classifying and arranging the books on the shelves. After mature consideration it was the opinion of the assistant librarian that the Decimal classification would best meet our needs, and

that system has been adopted. The miscellaneous books in the main library, numbering some 2650 volumes, have been properly arranged and author and subject cards written by Mr. McGuire and call numbers engrossed by Mr. Carlson on the back of each book and on each card.

The sets of periodicals and publications of learned societies have also been similarly arranged.

*San Diego meeting of the Western Society of Naturalists.*—As one of the societies affiliated with the Pacific Division of the American Association for the Advancement of Science, which met at San Diego August 9 to 12, 1916, the Western Society of Naturalists held its annual meeting at the same time and place. The Academy was well represented at these meetings, as many as twenty of its members appearing on the various programs for the presentation of papers. Two of the three presidential addresses were given by members of the Academy, the first by Dr. W. W. Campbell, President of the Pacific Division of the American Association for the Advancement of Science, whose subject was "What we know about Comets," the second by Dr. Barton Warren Evermann, President of the Western Society of Naturalists, his subject being "Modern Natural History Museums and their relation to Public Education."

The following members of the Museum staff were present and presented papers: Miss Alice Eastwood and Messrs. Dickerson, Evermann, Grinnell and Van Duzee.

#### ACCESSIONS TO THE MUSEUM

The accessions to the Museum during the year have been numerous, as set forth in the detailed list in the appendix to this report. Several important donations were received from exhibitors at the Panama-Pacific International Exposition, and many others from various and miscellaneous sources.

The Academy feels very grateful to all those who have in this way contributed to its collections.

#### RECOMMENDATIONS

*Addition to the Museum Building.*—Attention is again called to the necessity for additional room for the proper housing of

the Academy's collections and the proper display of exhibition materials already on hand or expected in the near future.

At the request of the President of the Board of Trustees the architect has submitted tentative plans and estimates for certain additions to the Museum building, as follows:

- a. Closing in the Court in such a manner as to provide one floor for exhibits; estimated cost, \$35,000; or
- b. Closing in the Court in such a manner as to provide two floors for exhibits; estimated cost, \$50,000; or
- c. A main hall for the contemplated East wing; estimated cost, \$90,000.

Any one of these plans would meet the present needs of the Museum fairly well.

*Taxidermists' Laboratory.*—The work of the Museum has been and is seriously handicapped because there is no suitable shop or laboratory in which the taxidermists and preparators can carry on their work. An item of \$1500 was provided in the budget for 1916 for such a building, but it was found that this amount would not construct a building that would meet the approval of the Park Commissioners. The matter was therefore abandoned for the time being.

By using one of the habitat group cases not yet needed for exhibits and by constructing a small shed or room on the roof, we were able to get along for the time being. This arrangement is necessarily merely temporary. A suitable, commodious shop must be provided soon if the work is not to be seriously hampered.

*Exhibits.*—There remain five spaces for large habitat groups, —three in the Mammal hall and two in the Bird hall. Provisional plans have been made for installing in the three cases in the Mammal hall a Humboldt Elk group, a Southern Mule Deer group, and a Fur Seal group. Some of the animals required for the fur seal group have been secured through the kind co-operation of the United States Bureau of Fisheries, and it is expected the others will be obtained next fall. Efforts to secure animals for the Humboldt elk and the Southern Mule deer groups have as yet been unsuccessful, but it is hoped they may be secured next fall.

It is proposed to install in the two remaining large cases in the Bird hall a White Pelican group and a Game Bird group showing all the species of ducks, geese and other game birds that winter in the San Joaquin Valley. Mr. Paul J. Fair with an assistant is now at the Los Baños Gun Club in Merced County collecting the birds for this group. The birds for the White Pelican group will be gotten in the spring.

In the Mammal hall provision has been made for 22 small mammal groups to be placed at either end of the large groups. The Bird hall has spaces for 12 similar small bird groups, two of which have already been installed, leaving 10 to be supplied.

It is hoped that provision may be made for securing as rapidly as possible the mammals and birds required for these small groups, and that a number of such groups be completed within the year.

*Research Collections.*—Attention is again called to the necessity of giving greater encouragement to research work than has been possible during the last few years. The reputation and standing of the California Academy of Sciences as a scientific institution will always be determined by the scientific workers connected with it and the contributions they make to the literature of the physical and biological sciences. Field investigations and explorations and the building up of the Museum's collections must be encouraged and provided for; and specialists and facilities must be provided for the study of the rich collections which the Museum already possesses and those which it may secure.

## APPENDIX TO THE DIRECTOR'S REPORT

## LIST OF ACCESSIONS TO THE MUSEUM AND LIBRARY, 1916

- Anderson, F. M., Berkeley, Cal.: Two turtle shells from Bolivar, Colombia, S. A.; and collections of Miocene, Eocene and Cretaceous fossils from near Coalinga, Cal. Gift.
- Argentine Government, through Hon. Enrique M. Nelson, Vice-Commissioner General, Panama-Pacific International Exposition: Thirty-nine specimens of mounted Argentine birds; eight mounted specimens of native mammals; 10 boxes of exhibits of native insects; 10 framed colored drawings of Argentine plants; a stereoscope and 37 slides; an exhibit illustrating water filtration; specimens of ores; 300 books and pamphlets; and 145 specimens of Argentine plants. Gift.
- Babcock, John P., Victoria, B. C.: Twenty-four sheets of botanical specimens from the West Coast of Vancouver Island, B. C. Gift.
- Bacon, Gaston E., San Francisco: Specimen of sand dollar from the ocean beach. Gift.
- Beardsley, Miss D. C., Pacific Grove, Cal.: One specimen of the whistling swan from Monterey, Cal.
- Berry, S. Stillman, Redlands, Cal.: Seven pamphlets. Gift.
- Blatchley, Hon. W. S., Indianapolis, Ind.: One copy of "Rhyncophora or Weevils of North Eastern America." Gift.
- Brandt, W. M., Gualala, Cal.: Two obsidian arrowheads. Gift.
- Branner, Dr. John C., Stanford University: Fifty-five bound volumes. Gift.
- Brasil, Prof. L., University of Caen, Caen, France: One pamphlet. Gift.
- California Botanical Club, through Miss Alice Eastwood: A collection of 397 specimens of Mexican plants collected by Dr. Edward Palmer in 1910, purchased for \$39.80 by the Club. Gift.
- California, University of, College of Agriculture, Berkeley, Cal.: Fifty-five numbers of the Bulletin of the College of Agriculture, nearly completing the Academy's set. Gift.
- Carlson, John I., California Academy of Sciences: One botanical specimen, exotic. Gift.
- Chastain, James, California Academy of Sciences: Specimens of obsidian and pumice from Siskiyou County, Cal. Gift.
- China, Government of, through the Commissioner-General, Panama-Pacific International Exposition: Two exhibit cases. Gift.
- Clemens, Chaplain Joseph C., Fort Sill, Oklahoma: A collection of about 300 specimens of frogs, lizards, toads, and snakes from China and the Philippine Islands. Gift.
- Clemens, Mrs. Joseph C., Fort Sill, Oklahoma: Five botanical specimens from Oklahoma. Gift.
- Coleman, Mr. R. A., San Francisco: Collections of minerals and fossils from Alaska. Gift.
- Cook, Melville T., New Jersey Agricultural Experiment Station, New Brunswick, N. J.: One pamphlet. Gift.
- Coombs, Mrs. A. L., San Francisco: Ten specimens of plants from the Yosemite Valley. Gift.

- Crocker, Hon. Wm. H., San Francisco: Three large folios—"Japanese Temples and Their Treasures." Gift.
- Dickerson, Dr. Roy E., California Academy of Sciences: Ten collections of Martinez fossils from the Simi Hills; eight collections of fossils from the Marysville Buttes; seven collections from the vicinity of Petaluma; and specimens of foraminiferal shales from Casmalia and Lompoc, Cal. Exploration.
- Dorne, Mrs. Nelly Waterhouse, San Francisco: One pamphlet. Gift.
- Drake, C. J., Ohio State University, Columbus, Ohio: Representatives of five recently described Tingids (Hemiptera) from the east. Gift.
- Durden, H. S., San Francisco: A map of California in which each county is represented by a piece of wood from some tree native and characteristic of the county, and a collection of fossils, mesozoic ammonoids, petrified wood from the auriferous gravels of California, and several fine specimens of California minerals. Gift.
- Eastwood, Miss Alice, California Academy of Sciences: Collections of botanical specimens from Colorado as follows: Two hundred thirty-four specimens from Grand Junction, 63 from Telluride, 155 from Durango, 85 from Trinidad, and 191 from the vicinity of Denver; a collection of about 500 specimens from the Grand Canyon, Arizona; 85 specimens from Gallup, New Mexico; 20 specimens from Williams, and 12 from Seligman, Arizona; a collection including 60 species, chiefly exotics, from Santa Barbara; 160 specimens, representing 140 native species, and specimens of 45 exotics, from Ventura Co., Cal. Exploration. A folio of postcards, made by Henry Hemphill; and two salamanders from San Francisco. Gift.
- English, W. A., U. S. Geological Survey, Washington, D. C.: A collection of Miocene and Pliocene fossils from west side San Joaquin Valley. Gift.
- Evermann, Dr. Barton W., Director of the Museum, California Academy of Sciences: Two sheets of specimens of *Spraguea umbellata* and *Spiraea splendens* from Crater Lake, Cal.; nine specimens of plants collected in the mountains back of Nordhoff, Ventura County, Cal.; 14 specimens of Colorado plants; 27 botanical specimens from Cottonwood Springs, seven from Mecca, Cal., 24 from Newhall, Cal., and 25 from Saugus, Cal.; specimens of the Walking Fern (*Camptosorus rhizophyllus*), from Knoxville, Tenn., collected in 1893; 10 manganese nodules dredged by the U. S. Fish Commission Steamer "Albatross" in the South Pacific during the Agassiz-Albatross South Pacific Expedition of 1899-1900; a collection of garnets from St. George Island, Pribilof Group; fossil leaves, Chignik Bay, Alaska; and one snake from Firebaugh, Cal. Gift.
- Field, C. F., San Diego, Cal.: Miocene or Pliocene fossils from Tia Juana Valley Oil Well. Gift.
- Giffard, W. M., Honolulu, T. H.: Eleven paratypes of Hymenoptera (5 species); and 126 California insects. Gift.
- Gordon, W. A., Los Angeles, Cal.: Miocene fossils from vicinity of Quail Lake on Osos Creek, Cal. Gift.

- Grant, Hon. J. D., San Francisco: One buffalo skull from Klamath River. Gift.
- Grinnell, Fordyce, Pasadena, Cal.: Twenty sheets and five duplicates of botanical specimens from Pasadena; 20 botanical specimens from Mt. Wilson; and 316 insects from vicinage of Los Angeles. Gift.
- Grove, Mrs. Jas., Camptonville, Cal.: One lizard from Yuba Co., Cal. Gift.
- Hawaii, Government of, through Commissioner-General, Panama-Pacific International Exposition: Three fishes and five eels from Diamond Head, Oahu; and one turtle from Makapu, Oahu. Gift.
- Henry, J. K., Vancouver, B. C.: Nine sheets of botanical specimens from Vancouver Island. Gift.
- Heyer, Mrs. H. C., San Francisco: Sixty-one specimens of Alaskan birds, chiefly water birds. Gift.
- Holm, Adolph, San Francisco: Three botanical specimens. Gift.
- Hubbard, Samuel, Oakland, Cal.: Fourteen specimens of a species of fish (*Cyprinodon macularius*) from Saratoga Springs, Death Valley, San Bernardino Co., Cal. Gift.
- Hunt, H. H.: One salamander from La Honda, Cal. Gift.
- Kelly, James H., Tiburon, Cal.: Twenty-one numbers of the earlier publications of the Academy. Gift.
- Klapp, Jesse R., San Francisco: A fine adult male specimen of the Western Goshawk (*Astur atricapillus striatulus*), from Golden Gate Park. Gift.
- Kusche, August, Eldridge, Cal.: One hundred and twenty-seven sheets of Arctic plants from Alaska and the Yukon; 19 specimens of birds from Alaska; six mineralogical specimens from Ketchikan; and 52 specimens of Neuroptera from Alaska. Gift.
- Logan, Hugh B., Baker, Ore., through Mr. John W. Mailliard, Sr., San Francisco: One skin of the Mountain Coyote (*Canis latrans lestes*), male, from North Powder, Baker Co., Ore., Feb. 10, 1916; and one skin of the Pallid Barred Wildcat (*Lynx fasciatus pallascens*), male, from Salisbury, Baker Co., Ore., Jan. 25, 1916, both collected by Mr. Logan. Gift.
- Loomis, L. M., San Francisco: One bound copy, Ridgway, Birds North and Middle America, vol. 7. Gift.
- Mailliard, Hon. John W., Sr., San Francisco: Two specimens of the California Condor (*Gymnogyps californianus*), collected in San Diego County, Cal., Jan. 1 and 3, 1894, by E. B. Towne; and one bound volume, "Egyptian Birds" by Charles Whymper. Gift.
- Martin, Bruce, Berkeley, Cal.: A collection of 627 insects collected in Colombia, South America, 126 of these being butterflies in papers, and the balance mostly beetles. Gift.
- McAllister, Otis and Miss Ethel, San Francisco: One wasp's nest. Gift.
- McGuire, Ignatius, California Academy of Sciences: Three snakes from Golden Gate Park. Gift.
- Meinecke, E. P., Washington, D. C.: Five pamphlets. Gift.
- Menzies, R. M., San Francisco: One beetle (*Buprestis aurulenta*) from Marin Co., Cal. Gift.

- Merriam, Dr. C. Hart, Washington, D. C.: A collection of 486 specimens of Atlantic coast mosses, comprising 65 genera and 181 species, all new to the herbarium; and a cross section of the largest tree of the California lilac, *Ceanothus thyrsiflorus*, measuring 14 inches in diameter, and two cross sections of other trees of the same species and one of *Rhamnus californica*. Gift.
- Miller, Mr. Charles E.: Thirty-five sheets of botanical specimens from Santa Rosa and Santa Cruz islands. Gift.
- Miller, Thomas L., San Francisco: One snake skin. Gift.
- Mitchell, Henry S., San Francisco: Twelve bound volumes; two nautical charts; 36 packages of shells; four fossils from the Santa Cruz Mountains; and a sextant. Gift.
- Moxley, George L.: Forty-one sheets of botanical specimens from Los Angeles, Cal. Gift.
- Nelson, Mr., San Francisco: Pleistocene fossils from Nome, Alaska, one mile north of present beach, four miles east of Nome. Gift.
- Oldroyd, T. C., Long Beach, Cal.: A collection of edible clams of California. Gift.
- Pack, Herbert J., Salt Lake City, Utah: One vial of shrimps (*Artemia*) from Great Salt Lake. Gift.
- Parker, Sir Gilbert, London: A collection of about 100 pamphlets, on the European War. Gift.
- Reynolds, L. C., San Francisco: A collection of insects in alcohol, and 336 insects, mostly Hemiptera. Gift.
- Rixford, Dr. Emmet, San Francisco: Specimens of *Trifolium Bolanderi* collected at type locality. Gift.
- Rixford, G. P., San Francisco: Seventeen sheets of botanical specimens from Riverside. Gift.
- Rosenbaum, L. S., San Francisco: A collection of 232 California insects. Gift.
- Ryfkogel, S. D., San Francisco: Alaskan bow, arrows, and spear, and three wooden bowls. Gift.
- Sargent, Prof. L. E., Cambridge, Mass.: A collection of 120 specimens of woody plants. Exchange.
- Shirk, Joseph, Berkeley, Cal.: One horned toad (*Phrynosoma*) from Berkeley; and specimens of salamander eggs. Gift.
- Slevin, Joseph R., California Academy of Sciences: Three snakes, 371 lizards and 47 toads from Pyramid Lake; one snake, nine lizards, and one frog from Carlin, and 10 snakes, two toads, and 12 frogs from Elko, Nevada; 13 snakes, 23 lizards, 137 frogs, and 15 toads from Boise; four snakes, 31 frogs, five toads, and two salamanders from Payette Lake; two snakes and 56 frogs from Geyer Hot Springs; four snakes, 42 lizards, and 46 frogs from Ft. Hall, Idaho; one snake from Portland, Oregon; two snakes, 165 lizards, from Thompson, and five salamanders and 127 frogs from Salt Lake City, Utah; one snake from Carmel, one from San Jose, one from Los Baños, five lizards from Stanford University, 17 snakes, four lizards and one toad from Golden Gate Park, and two mussel shells from the Humboldt River at Elko, Nevada. Exploration.

- Smith, L. E., Sisson, Cal.: Skull of a small mammal, collected at Hilts, Siskiyou Co., Cal.; specimens of two rare species of plants from northern California, and 149 bound volumes. Gift.
- Snodgrass, R. E., Washington, D. C.: Seventeen volumes and 38 pamphlets. Gift.
- South Dakota, through Mr. Chas. McCaffree, Commissioner of Immigration: Specimen of iron ore. Gift.
- Stonehouse, Miss Mabel E., Sisson, Cal.: Seven botanical specimens from Hilts, Siskiyou Co., Cal. Gift.
- Stoner, R. G., San Francisco: A collection of Upper Miocene fossils from Topo Canyon, Cal. Gift.
- Tough, F. B., Los Angeles, Cal.: Oil sands and buff-colored clay. Gift.
- Troyer, Carlos, San Francisco: Pamphlet, "Indian Music," by himself. Gift.
- United States Fisheries Steamer "Albatross": Twenty-one bird skins; specimens of fishes, sponges, molluscs, crustaceans, coelenterates, amphibians, annelids, bryozoa, echinoderms, worm tubes, worms, hydroids, algæ, shells, coral, plants, brachipods, 15 insects, eight tree frogs from Cerros Island, two tree frogs and two toads, from Sweet Water Valley, San Diego Co., Cal., and one rattlesnake from Turtle Bay, Lower California. Gift.
- United States National Museum, Washington, D. C.: Eighty-one specimens of cryptogams. Exchange.
- Van Denburgh, Dr. John, California Academy of Sciences: One Rough-winged Swallow (*Stelgidopteryx serripinnis*) from Edenvale, Santa Clara Co., one snake and seven salamanders from Stanford University, one snake, Sausalito, three snakes from San Jose, one snake, one toad and 12 lizards from Imperial Co., two lizards and two snakes from Merced, Cal. Exploration.
- Van Duzee, Edward P., California Academy of Sciences: Sixty-five specimens of insects from Los Baños; 338 specimens from Crystal Lakes, San Mateo Co.; 113 specimens from Mt. Diablo, Contra Costa Co.; 243 specimens from Niles; 87 specimens from San Francisco, 595 specimens from Lake Co., 490 specimens from San Diego, 36 specimens from Los Angeles, 124 insects from Leona Heights, Cal. Exploration. Sixteen pamphlets. Gift.
- Van Dyke, Dr. E. C., Berkeley, Cal.: Eight hundred and thirty-four insects. Gift.
- Varney, Mrs. F. N., San Francisco: One Short-eared owl. Gift.
- Von Geldern, Otto, San Francisco: Seventy-six insects from Louisiana. Gift.
- Waring, C. A., Berkeley, Cal.: Martinez fossils from the Simi Hills, Cal. Gift.
- Witham, Henry, San Francisco: Four bound volumes. Gift.
- Wickes, Miss E. M.: One botanical specimen from Santa Cruz, Cal. Gift.
- Wooster, John, San Francisco: One hummingbird nest. Gift.
- Wrasse, E., San Francisco: Specimen of oyster-shell. Gift.
- Young, Carlos, San Francisco: Copper ores and mineral cabinet. Gift.

## DEPARTMENTAL REPORTS

## DEPARTMENT OF BOTANY

By Alice Eastwood, *Curator*

The new Herbarium now contains 32,281 mounted sheets, representing 10,241 species and 3223 genera of Phanerogams and the higher Cryptogams. Besides these there are also the types saved from the fire and the bundles of lupines and gilies which were loaned at the time and have since been returned, but which are not yet incorporated in the herbarium on account of lack of room. There are also the collections of mosses given by Dr. C. Hart Merriam numbering 486 specimens, and 81 specimens sent in exchange from the National Museum. A collection of Hawaiian ferns and a collection of 100 plants from the Alps donated by Mrs. Zelia Nuttall after the fire have been this year mounted and put in place and almost all have added species to the collection that were very desirable. The California Botanical Club has purchased two collections at a total expense of sixty dollars.

Duplicates have been sent to the following herbariums:

Stanford University .....	230
Gray Herbarium of Harvard University.....	353
The Arnold Arboretum .....	411
The U. S. National Herbarium .....	765

Other sets of duplicates are ready for distribution but have not yet been sent and there remains still a large collection of duplicates made chiefly by the curator to be distributed into sets when time can be taken from more pressing duties.

After ten years' delay, the collection of plants from the Galapagos Islands can now be labelled. The collector has at last sent the data necessary to enable the field numbers to be correlated with the published numbers. It is an immense job which would be impossible without the classifying into families, genera and species already done by the curator. Thousands of labels will have to be written, as there are many duplicates. Help will be absolutely necessary for that labor and it should be paid for by the Academy, for it is too laborious and uninteresting for members of the Botanical Club. It is hoped that the coming year will see this collection incorporated into the herbarium and the duplicates distributed to other herbariums so that exchanges can be secured.

Without the help of some members of the Botanical Club, the herbarium could not be in its present fine condition. Mrs. Marian L. Campbell has mounted 6,854 specimens, Mrs. G. Earle Kelly 300, while Mrs. C. L. Pitcher, Mrs. Ernest Meiere, Miss Kate L. Stoney and Miss Lena Gibbs have helped in other ways. With an allowance of one hundred dollars for help, the mounting alone would have exceeded the appropriation by more than fifty dollars if the lowest price for such work should have been paid. I have had the paid help of two school girls who could come on Saturdays and after school and they have helped me in writing labels and making an inventory of the herbarium.

The Botanical Club holds weekly meetings. These are conducted by the curator and take the form of popular talks and excursions in the park and the country. The Club is growing constantly without advertisement of any kind and has done much to make the California Academy of Sciences a popular institution. Besides this Club, the curator also conducts once a week an evening class of the young gardeners in the park who desire a scientific knowledge of the plants they cultivate. I have had to correctly name a great many species in the park, and sometimes it is very difficult as we have not the books most needed.

The exhibition of flowers from the park and the country kept up in the vestibule of the Museum has taken some time each week, but it fills a popular want. Each species is labelled with scientific name, common name, if one exists, and the native country.

It is hoped in the coming year to have the principal genera of shrubs in the park arranged in scientific sequence around the court of the Museum with labels giving not only the names and native countries, but also the families under which they are classified. If there is room I plan also a bed of the plants mentioned in the Bible and another of the plants mentioned in Shakespeare's writings. It may not be possible to obtain all, but whatever can be secured will be of interest and may lead to the final completeness.

During a six weeks' leave of absence on a trip to Colorado, the curator made large collections which will be classified elsewhere in the report. A trip was also made to Ventura and Santa Barbara in the spring and in August a trip to Southern California to attend the Pacific Coast Branch of the American Association meeting resulted in the collection of a great many exotics in Southern California.

Merriam, Dr. C. Hart, Washington, D. C.: A collection of 486 specimens of Atlantic Coast mosses, comprising 65 genera, 181 species. Gift. Also a cross section of a large tree of *Ceanothus thyrsiflorus* measuring 14 inches in diameter, and two cross sections of other trees of same species, also one of *Rhamnus californica*.

U. S. National Museum, Washington, D. C.: Eighty-one specimens of Cryptogams in exchange.

The California Botanical Club has purchased a collection of 385 specimens collected in California and Oregon by A. A. Heller in 1916, also a collection of 397 specimens collected in Mexico by the late Dr. Edward Palmer.

George L. Moxley has sent on 50 from the vicinity of Los Angeles for determination.

Fordyce Grinnell, Sr., has given 52 from the Sierra Madre mountains, to be named.

Miss Anna Junkans has sent 82 from Trinity County as a gift and for determination.

G. P. Rixford has contributed 37, chiefly exotics.

Mr. Charles E. Miller: Thirty-five sheets of specimens from Santa Rosa and Santa Cruz Island, also six from near Cisco.

Mrs. Ernest Meiere: Seven California species.  
Dr. Barton W. Evermann: Ninety, chiefly from California.  
Mrs. G. Earle Kelly: Thirty-four, chiefly from Monterey County.  
Ida M. Blochman: One from Mariposa County.  
Mrs. Arch M. Gilbert: Four from California.  
Colin Eastwood Clegg: Sixteen from Scenic, Washington.  
Mrs. Marian L. Campbell: One hundred sixty-five from high Sierras.  
Mrs. Thos. Palache: One *Torreya* from Sierras.  
Fred Koch: One rare anemone from California.  
Arthur L. Bolton: Forty-five from parts of California and Arizona.  
J. P. Babcock: Twenty-four from West Coast of Vancouver.  
T. D. A. Cockerell: One hundred seventy-two, chiefly New Mexico.  
J. K. Henry: Nine, Vancouver.  
Dr. A. Lyle: One fern from Massachusetts.  
J. Aug. Kusche: One hundred thirty from Yukon and Alaska.  
Miss Julia McDonald: One hundred eighty-six from Fresno County.  
William H. Suksdorf: Six duplicate types.  
Argentine: One hundred forty-five.  
Mrs. A. L. Coombs: One hundred thirty-six California and Oregon.  
C. S. Sargent: One hundred twenty exchange from Arnold Arboretum.  
Adolph Holm: Four exotics.  
Miss E. M. Wikes: One.  
Miss Mabel E. Stonehouse: Seven.  
L. E. Smith: Two.  
John Carlson: One.  
The Curator: Two hundred seventy-five Grand Canyon, 587 exotics, 354 miscellaneous, 158 Ventura County, 162 Grand Junction, 117 Durango, 166 near Denver, 50 Trinidad, 50 Telluride, 33 Needles, 15 Seligman, 20 Williams, 64 Gallup.

#### DEPARTMENT OF HERPETOLOGY

By John Van Denburgh, *Curator*

Report of the Curator of the Department of Herpetology for the year 1916.

At the beginning of the year 1916 our collection of reptiles and amphibians numbered 32,280. There have been added during the year 1536 specimens, so that we now have 33,816.

The principal sources of the specimens received during the year have been as follows:

From California: Thirty-six snakes, 25 lizards, 10 salamanders, 4 toads, 2 frogs.

From Nevada: Fourteen snakes, 378 lizards, 48 toads, 13 frogs.

From Utah: Two snakes, 176 lizards, 5 salamanders, 127 frogs.

From Idaho: Twenty-three snakes, 64 lizards, 282 frogs, 5 toads, 2 salamanders.

From Oregon: One snake.

From Texas: Three salamanders.

From Mexico: One snake, 8 frogs.

From Colombia, S. A.: Two turtle shells.

From the Hawaiian Islands: One turtle.

From the Philippine Islands: Eight lizards, 9 frogs.

From China: Fifty-three turtles, 9 snakes, 52 lizards, 114 frogs, 59 toads.

During the year much progress has been made in classification and arrangement of the collection on the shelves. This work involves the separation, identification, rebottling, labeling and card-cataloguing of the entire collection of nearly 34,000 specimens. This huge task is now more than one-third completed.

Considerable scientific work also has been done during the year. Two short papers have been published, and two others presented for publication, while several others are in process of preparation. Among these are one on the reptiles of Nevada and one on those of Idaho.

During the coming year, it is hoped that the permanent installation of the collection may be still further advanced and the collection much increased in size. It long has been my desire to make the Academy's collection of reptiles and amphibians the largest and most valuable in America. The field is open to the Academy and there is no good reason why it should not avail itself of the opportunity to exceed all other museums in this line of research. The collection now is very large and ranks probably third in America, being exceeded by the collections of the United States National Museum and of Harvard University, each of which is perhaps fifty years older than our own. The growth of our collection during the years since the great fire has been phenomenal, but in the last five years, owing to lessened appropriations for field work, the rate of growth has been much reduced. The number of specimens added during each of the past six years has been, in round numbers, as follows:—

1911	.....	6100	specimens
1912	.....	3500	"
1913	.....	2700	"
1914	.....	800	"
1915	.....	800	"
1916	.....	1500	"

This is an average for the last four years of only 1450 specimens as against an average growth of over 4000 for each of the preceding seven years. The number received during the year 1911 was over 6100 specimens, but in 1914 and 1915 this was reduced to nearly 800. This reduction in the rate of growth is due to the reduction in the amount of money available for field work. The present rate of growth is quite inadequate to secure pre-eminence for our collection. If we are to do this the rate of growth must at least be restored to its former standard, and such restoration in the rate of growth means that there must again be made available larger sums of money to be devoted to this purpose. Now that the building in the Park has been completed, I hope that this may be done.

## DEPARTMENT OF INVERTEBRATE ZOOLOGY

By Walter K. Fisher, *Curator*

Since the Department of Invertebrate Zoology is in a formative stage the work for the year has emphasized the accumulation of a collection.

Systematic collecting was conducted at three points along the California coast:

1. By the curator, at Monterey Bay and vicinity, during June.
2. By Mr. Carl Hubbs, in the region of Point Conception, during June.
3. By several members of the Department of Biology, University of Southern California, during a two-weeks' cruise of their dredging boat about Santa Catalina Island.

These have resulted in the accumulation of a considerable amount of material, which is being sorted.

In addition, the curator secured from Mr. W. F. Thompson of Stanford University a very valuable collection of west coast Gephyrean worms, as well as a miscellaneous collection of invertebrates taken in British Columbia and along the coast of California.

A small collection of Southern California echinoderms was donated by the University of Southern California.

A representative series of invertebrates was collected in the vicinity of Hilo, Hawaii, by Miss Leslie Tulloch, and after her untimely death was sent to the Academy by Miss Martha Tulloch.

Prof. Frank W. Weymouth, of Stanford University, has contributed a small lot of echinoderms and crustacea from Boundary Bay, B. C.

## DEPARTMENT OF INVERTEBRATE PALEONTOLOGY

By Roy E. Dickerson, *Assistant Curator*

In accordance with your request of January, the assistant curator is pleased to report concerning the activities of the Department of Invertebrate Paleontology for the current year. With a small appropriation for field work this year, the department has been able to accomplish much very desirable exploration and investigations in three different portions of California. Laboratory studies on the Oligocene of Washington and California, the Miocene of the Mexican Gulf Coast, the Caribbean, Panama and Lower California, the Pleistocene and Pliocene of Sonoma County, the Martinez-Eocene of the Rock Creek Quadrangle in Southern California, the Eocene of Mexico have been completed or are in progress. Some exhibit material has been arranged and more is in course of preparation for exhibition in the Museum.

## CARE OF COLLECTIONS

The paleontological collections are practically all numbered with locality number, and the types, cotypes and figured forms given catalogue numbers as well. The conchological collections are only partially numbered, but

the Hemphill conchological catalogue is almost completed. Approximately one-half of the Henry Hemphill conchological collection is unpacked, numbered and placed in drawer cases or exhibition cases. But little work has been attempted on the excellent collections of rocks and minerals obtained from the Exposition.

#### RESEARCH

During the first three weeks of June, the assistant curator investigated the Eocene and Cretaceous in the Simi Hills, which are 30 miles northwest of Los Angeles. Lower Eocene fossils of the Los Angeles basin exhibit the same peculiar facies as the Martinez fauna of the San Francisco basin. The abundance and variety of Turritellas, the Volutidæ, the Cypræidæ, and other tropical and semi-tropical forms, in comparison with the fauna of the San Francisco basin, are evidences yielded by these collections that apparently well-marked climatic zones existed during lower Eocene time, in marked contrast with the vague and indefinite climatic conditions of the Upper Eocene, Tejon, during which semi-tropical conditions existed far north of the Equator. Palms and other tropical or semi-tropical forms of the land flora occur in Washington while semi-tropical invertebrate shells are numerous in the Cowlitz phase of Washington.

Both the *Rimella simplex* zone or middle Tejon, and the *Siphonalia sutterensis* zone of the uppermost Tejon, were recognized in the vicinity of the Simi Hills. About five miles north of Chatsworth Pass, Mr. R. G. Stoner discovered an interesting locality which yielded numerous species characteristic of the uppermost Eocene of California, the *Siphonalia sutterensis* zone. This zone typically occurs in the Marysville Buttes, Sacramento Valley, and also extends along the western border of the Sierra Nevada, the marine equivalent of the land-laid auriferous gravels. This is the first recognition in California of the *Siphonalia sutterensis* zone in the outer Coast Ranges. Presumably, in most places in the coast ranges, the uppermost Eocene was removed during the interval of emergence between the Eocene and Oligocene on the Pacific Coast. About 15 new species from the Martinez-Eocene and about 12 forms new to science were found in the Tejon Eocene in this area.

The Marysville Buttes were visited in April by the assistant curator. Eight different collections were obtained from the uppermost Eocene of this region. Ten beautiful new species were found. Knoxville Cretaceous fossils were discovered for the first time in this ancient volcano of the Sacramento Valley. The uppermost Cretaceous, Chico group, was discovered in four different localities and fair collections were obtained. No Horsetown or middle Cretaceous was found in this area; presumably an interval of erosion in this region represents Horsetown time, as these deposits occur in great thicknesses 30 miles west of the site of the Marysville Buttes, or faulting has uplifted the lower Cretaceous—the Knoxville—and lowered the upper Cretaceous, the Chico, and concealed the middle or Horsetown member of this Mesozoic period.

During three weeks in July, the assistant curator, aided by Mr. John B. Kerr, collected from seven different localities in the Merced formation,

between the ocean and Petaluma and northwest in the vicinity of Freestone. The type locality of the Merced, a Pliocene formation, is located in a cliff section  $3\frac{1}{2}$  miles north of Mussel rock, where about 5000 feet of sands and shales are exposed. These collections demonstrate the presence of Merced strata resting unconformably upon an old erosion surface cut in ancient Franciscan rock of probable Jurassic age. Sonoma tuff, a volcanic ash and pumice deposit, was found interbedded with Merced strata in the vicinity of Freestone and environs. This tuff occurs in very extensive deposits east of Napa, and occurs at the base of the Orindan formation near Pinole. The Orindan formation which consists of lake deposits, landlaid deposits, and interbedded volcanics is an extensive formation of the Berkeley Hills. Probably it is the equivalent of the marine Merced. This correlation is further reinforced by the discovery that the Lawlor ranch beds of Sonoma Mountain, which consist of sands, gravels and clays of an intervolcanic period rest upon andesite and Sonoma tuff. These beds have yielded *Neohipparion gidleyi* Merriam. Neo-Hipparion also occurs in the Orindan strata, and the Etchegoin of the western border of the lower San Joaquin Valley.

Three collections from an ancient lake deposit east of Petaluma were obtained. Apparently a portion of the Petaluma lake beds represents a period of time somewhat younger than any of the marine Miocene of San Pablo age, as brackish water fossils were found in two localities. These fossils are identical with forms which occur in a similar deposit in the upper portion of the San Pablo formation of the Carquinez Straits vicinity, a marine formation about 2000 feet thick. Here we have apparently a transition from marine to brackish water and finally to fresh water conditions in this Miocene basin.

In summary then:

The region lying between Tomales Bay and the top of Sonoma Mountain is a block which has been but little disturbed by folding or faulting since the Pliocene. This wave-cut block has, however, been warped so that it tilts from the sea towards Sonoma and Petaluma valleys, is uplifted near Freestone on the northwest to 1100 feet, but is only 500 feet in elevation 20 miles south on the shore of Tomales Bay.

The formations involved are in order, the Franciscan group, Petaluma lake beds of upper Miocene age, Marine Merced Pliocene, Basalts, Andesites, interbedded tuffs and sandstones of inter-volcanic period of the Sonoma Mountain region, stream terraces and marine terraces of Pleistocene age.

Marine Miocene may exist beneath Sonoma Mountain, as is indicated by oil sands and oil impregnated basalts at one locality east of Petaluma.

Sonoma tuff is interbedded with the Merced formation at Freestone.

The Merced formation is the correlative in a broad way of the Sonoma tuff, the Pinole tuff, the Orindan, and probably the upper portion of the Etchegoin-Jacalitos of the San Joaquin Valley.

The Hayward fault on the west side of Sonoma Mountain exhibits many characters which are due to recent movements which produced earthquakes during recent historic time.

At the invitation of Dr. L. F. Noble of the U. S. Geological Survey, the assistant curator spent two weeks last December in an area on the southern border of the Mojave Desert, the north flanks of the San Gabriel Mountains. This region is in a zone of great faults. Here we find blocks of Tertiary sediments dropped in between great breaks in the earth's crust. In these sediments both marine and land forms were found imbedded. From these fossils and stratigraphy as bases, the historical geology of this region is being worked out. Some relations of the land laid deposits of the Great Basin region with the marine of the Pacific Coast and Gulf of California are being solved in this field. The nature of recent faulting and its resultant topographic forms are wonderfully exemplified in this field. The results of this work will be published in collaboration with Dr. Noble, as a Professional Paper of the U. S. Geological Survey.

#### PUBLICATIONS

Dr. C. E. Weaver published three papers in the Academy Proceedings during the current year:—Eocene of Lower Cowlitz River Valley, Washington; The Post-Eocene Formations of Western Washington; and The Oligocene of Kitsap County, Washington. The Stratigraphy and Fauna of the Tejon Eocene of California was published by the assistant curator in the University of California Publications. A paper entitled The Stratigraphic and Faunal Relations of the Martinez Formation to the Chico and Tejon of Southern California, by Mr. C. A. Waring and The Fauna of the San Fernando Formation of Northeastern Mexico by R. E. Dickerson and W. S. W. Kew have been accepted for publication. Papers entitled: Geology of a Portion of the McKittrick District, by Mr. G. C. Gester, Ancient Panama Canals, Climatic Zones of Martinez-Eocene Time, Climatic Conditions During the Oligocene with Descriptions of New Species from the Oligocene of Washington, by R. E. Dickerson, have been submitted to the committee on publication. A paper on the Geologic History of the Marysville Buttes is in course of preparation by the assistant curator.

#### EXHIBITS

The Standard Oil Company has installed an oil exhibit in the east wing of the building and is now adding to, and improving it. Two cases of fossils representative of the oil bearing rocks are installed in connection with this valuable exhibit.

A portion of the Henry Hemphill conchological collection showing variation is on exhibition in the main Museum hall. Typical shells from this collection are being arranged in the reference room.

Fossil freshwater fishes from an Eocene lake in Wyoming, a collection of rocks and minerals from Washington, and a collection of the edible clams of California are also displayed in the main hall.

#### DONATIONS

During the year many donations of valuable specimens have been received by the Museum, which have been added to the research collections of this department, as set forth in detail in the Director's report.

## LIBRARIAN'S REPORT

By Edward P. Van Duzee, *Assistant Librarian*

Please allow me as assistant librarian to submit the following report on the work done in this department during the past fiscal year, together with a few suggestions for the coming year.

My connection with the library began on June first, 1916. I then found that after the removal of the library to the new Academy building the books had been placed on the shelves. The periodicals, the publications of societies and the administrative and scientific reports of the Federal and of the state governments, had been segregated and arranged in proper order, but only partially collated. Some of the more important individual books had been sorted out and arranged on the shelves in the reading room and a start had been made toward classifying them after the Library of Congress system. After correspondence with neighboring libraries and consultation with yourself and the members of the Academy staff it was finally decided to follow the majority of similar institutions and adopt the Decimal Classification as the one best suited to our needs. The first work done was the classification and arrangement of the miscellaneous books in the main library. The books so treated numbered 2650 volumes. Author and subject cards for these were written by Mr. Ignatius McGuire, and Mr. John Carleson engrossed the call number upon the back of each book and on each card. The sets of periodicals and publications of learned societies have also been classified and the cards for them made and engrossed, and those in the English language and a considerable part of those in foreign languages have been collated. The catalogue cards have been alphabetized in two series, one including the author and title cards, the other the subject cards, so there is now a fairly useful catalogue of the books in the main library but including very few analyticals. Current accessions to the library are entered and acknowledged as soon as possible after their receipt. An accession register has been started but is not yet nearly complete. Mr. McGuire has made the entries in this register, which now number 5401.

The most important work in this department for the coming year will be the classification and cataloguing of the state and Federal government publications in the main library and of the books in the laboratories of the departments of Botany, Ornithology and Paleontology, the books pertaining to the other departments having been mostly attended to in connection with the work on the main library. The preparation of a card shelf-list and the completion of the accessioning are other important matters to claim attention during the coming year.

I would like to suggest the desirability of having a moderate appropriation in this department, of perhaps \$100, in the next fiscal year for the purchase of Library of Congress and American Library Association analytical catalogue cards for certain important sets of serial publications, a smaller sum for the construction of a wall case in the reading room suitable for the shelving of current serials and new accessions, and not less than \$200 for the binding of a few important books and serial sets. The

binding of serial publications in a scientific library is always an important and considerable item in the fixed charges of the institution and it is rarely advisable to postpone such expenditures too long or the binding of the accumulated volumes may become a serious problem.

DEPARTMENT OF ENTOMOLOGY

By Edward P. Van Duzee, *Curator*

I beg to submit the following report on the condition and work in the Department of Entomology for the current fiscal year, including a few suggestions for the ensuing year.

My appointment as curator of this department took effect on June first, 1916, and on assuming the duties of the position I found the collections of the department unorganized and unarranged, although well cared for and in excellent condition. The first work done was the fumigation of the laboratory with hydrocyanic acid gas to kill museum pests introduced into the room with the Galapagos tortoises that had been temporarily stored there. Suitable book shelving was then erected, the books pertaining to the department were brought in from the main library, and the scientific apparatus and property of the department was unpacked and made available for use.

The collection of insects was found to be in almost perfect condition with practically no infestation by museum pests. There were about 200 trays well filled with mounted specimens and about 60 trays filled with unmounted material in boxes and papers. A portion of the mounted material had been properly labelled for locality and collector, but the larger part was without such labels. It has been my first duty to get this material labelled so it can be made available for study and exhibition. Many thousands of these labels have been printed and attached to the specimens and this work is now nearing completion, so the arrangement and classification of the collection can soon be begun.

During the year 4859 specimens have been added to this department by gift or through collections made by myself, and these have all been mounted and properly labelled. Very little field work was done during the year. I spent one day at Los Baños, two at or near Mt. Diablo and three in Lake County. On the last two trips I went as the guest of Mr. W. M. Giffard, so the total expense to the department for all trips was but \$6.75. I also spent two days collecting about San Diego, a few hours at Manhattan Beach, Los Angeles, and took several Sunday trips about the Bay district without expense to the department. The total accessions from these collecting trips number 1976 specimens.

During the year two collections have been sent to specialists for study. The Orthoptera of the Galapagos Expedition were sent to Messrs. Hebard and Rehn and the Plusiini to Dr. Ottolengui.

A portion of my time during the past year was devoted to the study and determination of insects for correspondents of the Academy and to the publication of a bibliographical and synonymic Catalogue of the Hemiptera

of America north of Mexico. This catalogue will soon be issued as a volume of the semicentennial publications of the University of California.

A collection of butterflies for temporary exhibition in the Mammal Hall of the Academy was prepared soon after the formal opening of the Academy building. This collection consists of 12 trays of showy exotic species and six trays of carefully determined and labelled California species which it is hoped may be of interest to children taking nature work in the public schools and to those beginning a collection of local insects and wishing help in the determination of their captures.

Looking ahead to another year the most urgent duty of the curator of this department will be the classification and arrangement of the North American material now in the collection so it will be available for scientific research. Of scarcely less importance is the accumulation of a more complete collection of the insects of California as a basis for the ecological and taxonomic study of our insect fauna. Another matter of importance in outlining the work of the coming year is the inauguration of a system of recording the material in the collection and for this purpose a card system of species-records and a book record for current lots as received and for type material seems the most practical and useful. The preparation of a permanent exhibit, especially of the insects of our own State, should not be neglected, and later when our material has been worked over and made more available the preparation of life history groups can be undertaken to good advantage. For the preparation of these exhibits and for the mounting and labelling of the accumulated material now on hand, some provision should be made in the estimates for the coming year that will allow the employment of an assistant to the curator occasionally as circumstances may require. I might add that much of this accumulated material is of great scientific interest and is indispensable for study, but in its present condition it is entirely unavailable for such purposes and practically inaccessible, and it is important that it be mounted and suitable cases provided for its reception. Much of the work of this department in the past has been the accumulation of material, but it now seems desirable that this material be made available to our own students and to other specialists who may wish to undertake its study so the Academy may profit by their labors and acquire the types and paratypes of the new species.

## FINANCIAL STATEMENTS

## REPORT OF THE TREASURER

for the fiscal year ending March 31, 1917:

April 1, 1916, Cash Balance.....	\$ 129.38
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*Receipts*

Dues .....	\$ 1,539.75	
Chas. Crocker Scientific Fund Endowment In- come .....	1,065.74	
James Lick Endowment Income.....	42,890.81	
General Income Account.....	20,165.03	
John W. Hendrie Income.....	607.50	
Bills Payable.....	631,300.00	
W. B. Bourn Donation.....	1,014.02	
Jos. D. Grant Donation.....	832.78	
Herbert Fleishhacker Donation.....	1,000.00	
J. S. Tobin Donation.....	250.00	
W. G. Wright Fund.....	38.50	
California Elk Expense.....	125.00	
Museum Appro. No. 32 Exhibits.....	1,077.86	
Museum Appro. No. 6 Botany.....	.45	
Museum .....	17.75	
Publication .....	10.21	
Appro. No. 10 Publication .....	66.20	
Appro. No. 40 Library .....	10.00	
Appro. No. 41 Desert Bird Group.....	18.00	
Post Card Sales.....	66.74	
Sundry Accounts .....	9.55	
		702,105.89
Carried forward .....		\$702,235.27

REPORT OF THE TREASURER—*Continued**Receipts*

Brought forward,—total receipts..... \$702,235.27

*Expenditures*

Expense .....	\$ 1,951.36	
Expense, Attorney's Fees.....	1,500.00	
General Salary Expense.....	11,710.00	
Bills Payable .....	634,100.00	
Insurance .....	1,266.35	
Interest .....	21,671.97	
Museum .....	\$ 108.95	
Museum, Department Appro.....	11,851.12	
Museum, Depart. Appro., Salaries..	10,715.76	
	<hr/>	22,675.83
Desert Bird Group.....	340.23	
San Joaquin Valley Game Bird Group.....	537.02	
San Joaquin Valley Bird Group.....	473.08	
Library .....	721.36	
Publication .....	1,592.69	
Museum Construction .....	4,006.00	
California Elk Expense.....	72.60	
Office Furniture .....	93.45	
Tools and Equipment.....	341.45	
Post Cards Purchased.....	79.30	
Sundry Creditors .....	38.52	
Sundry Advances (Museum) .....	780.00	
Contingent Fund .....	276.25	
	<hr/>	\$704,227.46
March 31, 1917, Balance Due Crocker National Bank .....		\$ 1,992.19

RUDOLPH J. TAUSSIG, *Treasurer.*

Examined and found correct.

McLAREN, GOODE & Co., *Auditors.*

San Francisco, Cal., April 18, 1917.

## INCOME AND OPERATING EXPENSES

from April 1, 1916, to March 31, 1917:

*Income*

Chas. Crocker Scientific Fund Endowment Income .....	\$ 1,065.74	
James Lick Endowment Income.....	42,890.81	
General Income Account.....	20,165.03	
Dues .....	1,639.75	
	<hr/>	\$65,761.33

*Expense*

Salaries .....	22,425.76	
Expense, General .....	\$1,063.58	
Fuel .....	333.11	
Electricity .....	176.75	
Telephone .....	306.00	
Postage .....	159.58	
Stationery and Printing..	244.99	
	<hr/>	2,284.01
Legal Expense .....	1,370.00	
Insurance .....	1,266.35	
Interest .....	21,671.97	
	<hr/>	49,018.09
Surplus for year 1916-17.....		16,743.24

## BALANCE SHEET

March 31, 1917.

*Assets*

Real Estate—		
Market Street Lot.....	\$600,000.00	
Jessie Street Lot.....	8,083.65	
Commercial Building .....	516,818.66	
		\$1,124,902.31
Stocks—		
45 Shares, Savings Union Bank and Trust Co .....		10,000.00
Museum Construction .....		187,855.28
Museum—		
General Collections .....	52,583.61	
Exploration .....	12,906.50	
Tools and Equipment.....	11,314.44	
Wm. H. Crocker Donation—		
Farallon Islands Bird Group.....	2,318.73	
W. B. Bourn Donation—		
Desert Bird Group.....	2,659.31	
J. D. Grant Donation—		
San Joaquin Valley Bird Group.....	2,610.42	
Herbert Fleishhacker Donation—		
San Joaquin Valley Game Bird Group, in process of installation.....	885.55	
		85,278.56
Library—		
Books and Equipment.....	14,420.74	
Publication .....	10,987.89	
		25,408.63
Office Furniture .....		2,543.84
Sundry Advances .....		16.55
		<u>\$1,436,005.17</u>

*Liabilities*

Endowments—		
James Lick Endowment.....	\$804,902.31	
Chas. Crocker Scientific Fund Endowment.	20,000.00	
John W. Hendrie Endowment.....	10,000.00	
		\$ 834,902.31
John W. Hendrie Endowment Income Account		8,677.50
Alvord Bequest, Botanical .....		5,000.00
Herbert Fleishhacker Donation.....		1,000.00
W. G. Wright Fund.....		123.70
Bills Payable .....		331,275.00
Sundry Creditors .....		311.28
Cash—		
Overdraft with Crocker National Bank....	1,992.19	
Less Cash in Safe.....	63.63	
		1,928.56
Surplus .....		252,786.82
		<u>\$1,436,005.17</u>

## AUDITORS' CERTIFICATE

We have examined the foregoing Balance Sheet, together with the books and accounts of the CALIFORNIA ACADEMY OF SCIENCES, and in our opinion it is properly drawn up so as to exhibit a true and correct view of the Academy's affairs, as shown by the books.

McLAREN, GOODE &amp; Co.,

San Francisco, Cal., April 17, 1917.

Certified Public Accountants.



## EXPLANATION, PLATE 3

## SAN JOAQUIN VALLEY ELK

*(Cervus nannodes)*

This elk, which is restricted to California, formerly ranged in great numbers over the Sacramento and San Joaquin Valleys, and westward through the Cuyama Valley into Santa Barbara County and through Santa Clara County to the coast at Monterey.

As a result of persistent persecution the great herds became reduced almost to extermination. A small band, the last of their race, took refuge on the ranch of Messrs. Miller and Lux, cattlemen, in Kern County. By the order of Mr. Henry Miller this band was rigidly protected and permitted to increase until now it numbers more than 400 head.

Recently the California Academy of Sciences, with the co-operation of Messrs. Miller and Lux and the California Fish and Game Commission, caught and distributed about 150 of these elk to various large public reservations in California. The results are very encouraging and it is believed a number of new herds will become established.

At certain seasons these elk resort to the great tule swamps; hence the name "Tule Elk," sometimes used to distinguish this species from the larger elk which inhabits the more humid coast belt north of San Francisco.

The animals in this group were obtained in Kern County, Cal.

Group prepared under the direction of John Rowley.

Background painted by Charles Abel Corwin.

Photo by Gabriel Moulin.







## EXPLANATION, PLATE 4

## COLUMBIAN BLACK-TAILED DEER

*(Odocoileus columbarius)*

This group represents a summer scene in Mendocino County, California, where the deer shown were taken. At this season the deer assume what is known as the "red coat," which is gradually shed, changing to the bluish coat. The hair then becomes grayer in color as it lengthens for the winter months. In the spring the long hairs of the winter coat are shed and again replaced by the short red coat of summer.

The horns are shed annually, usually in February and March. The entire antler drops off from the skull at the base of the horn or "burr." A new horn sprouts out from the skull and, normally, develops into the antler characteristic of the species. During the process of development the horn is covered with skin and hair, as shown on the males of this group. This hairy covering is known as the "velvet." When the horn has reached its maximum growth it gradually hardens, then the animal rubs the antlers against trees and bushes and wears away the velvet covering, leaving the horns hard and polished.

The common belief that a deer develops a new point on the antlers each year and that the number of points indicates the age of the animal is erroneous.

Group prepared under the immediate direction of John Rowley.  
Background by Charles Abel Corwin.  
Photo by Gabriel Moulin.







## EXPLANATION, PLATE 5

## ROCKY MOUNTAIN MULE DEER

*(Odocoileus hemionus)*

This splendid deer is of wide distribution. In California it is found in the Sierras from Kern County northward, coming to the coast in the northern counties. The animals here shown were taken in Siskiyou County in October.

This is the largest of the North American deer, the adult males in prime condition weighing nearly 400 pounds.

The name "Mule Deer" is sometimes applied to this species because of its long ears and its mule-like tail.

Group prepared under the direction of John Rowley.

Background painted by Charles Abel Corwin.

Photo by Gabriel Moulin.







## EXPLANATION, PLATE 6

## ANTELOPE

*(Antilocapra americana)*

The Antelope or Pronghorn formerly ranged in immense numbers over the plains and valleys of North America west of the Mississippi River from Mexico to Canada. In California great herds were found throughout the Sacramento and San Joaquin Valleys and in other valleys to the north, east and south. As a result of persistent persecution and slaughter for their hides and meat, these animals have, in most parts of their range, been entirely exterminated. In southeastern Oregon and northwestern Nevada they are still common. In California small isolated bands are still left. In all these States they are protected by law.

The Antelope is the only member of the hollow-horned animals which annually sheds its horns. Only the outer shell or sheath, however, is shed, and not the entire horn, as in the deer and elk.

The Antelope is also unique in not possessing dew claws or accessory hoofs on the backs of the feet, as in the deer.

Group prepared under the direction of John Rowley.

The background was painted by Charles Abel Corwin.

Photo by Gabriel Moulin.







## EXPLANATION, PLATE 7

## DESERT MOUNTAIN SHEEP

*(Ovis nelsoni)*

This species of mountain sheep or bighorn is found in the desert mountains of southern California and adjacent parts of Nevada, Arizona and Mexico. The animals in this group were taken in December, 1913, in the San Jacinto Mountains, Riverside County, California.

The slender horns of the females have given rise to the mistaken belief that the Ibex—an animal found only in Europe and Asia—is found in America.

The story that mountain sheep sometimes jump from high precipices and alight on their horns is entirely erroneous, and is on a par with the hoopsnake, sea serpent and other similar stories.

In the desert mountains water is usually scarce, and the mountain sheep frequently eat the barrel cactus, the pulpy interior of which contains a large percentage of water; and this no doubt enables the sheep to go for long periods without drinking.

This group was prepared under the immediate direction of John Rowley. The background was painted by Charles Abel Corwin.

Photo by Gabriel Moulin.







## EXPLANATION, PLATE 8

## MOUNTAIN LION

*(Felis oregonensis)*

The Mountain Lion, in its various forms, is found from Patagonia to Canada, and from the Atlantic to the Pacific. In different parts of its range it is known by different names, as Panther, "Painter," Cougar, etc.

Although not so common as formerly, it is still plentiful in certain sections of California, especially in the northern part of the State. The animals in this group were taken in Humboldt County. The Mountain Lion is the largest of the North American cats. It is very destructive to deer and certain domestic animals, particularly colts and sheep. It has been estimated that each lion in California kills on an average one deer a week throughout the year. So destructive is it that the State pays a bounty of \$20.00 each for its capture. Up to June 30, 1916, the State had paid bounties on 2,534 lions.

Although the Mountain Lion is looked upon as a very fierce animal and more or less of a menace to human beings, it is really a very wary animal, and instances of its attacking man are rare indeed. It is generally easy to tree, even with a cur dog, and chasing it with dogs is the method usually employed in its capture.

Group prepared under the direction of John Rowley.

Photo by Gabriel Moulin.







## EXPLANATION, PLATE 9

## NORTHWESTERN BLACK BEAR

*(Ursus americanus altifrontalis)*

The Black Bear in its various forms ranges generally from the Atlantic to the Pacific and from northern Mexico to Alaska. The specimens in this group were taken in Humboldt County, California.

In California, as elsewhere, the Black Bear may be either black or brown. In some instances both black and brown cubs are found in the same litter, and with either a black or a brown mother. Brown bears are sometimes confused with the Grizzly, which is now believed to be extinct in California.

Black bears occasionally kill sheep and pigs, but they live chiefly on nuts, roots and berries. Grubs, worms and insects also enter largely into their menu.

As a rule the Black Bear is a wary animal and will rarely or never attack a man unless wounded or cornered.

From one to four cubs (usually one or two) are produced in a litter. The cubs are usually born in January (in California) and are helpless little creatures; their eyes, like those of puppies and kittens, are closed and do not open for some time. They have no teeth and are almost naked. Although the mother bear may weigh three or four hundred pounds, the whole litter of cubs will weigh less than a pound. The cubs shown in this group were about two months old when taken.

Group prepared under the direction of John Rowley.

Photo by Gabriel Moulin.







## EXPLANATION, PLATE 10

## LEOPARD SEAL

*(Phoca richardi geronimensis)*

These interesting seals are fairly common in many places along the California coast, particularly in the bays. Unlike the fur seals which are highly polygamous, the harbor seals are monogamous. On the California coast the young are born in April and May; one pup is the rule. These seals are not migratory, nor are they as gregarious as other seals. They are comparatively silent, not making a loud roaring or barking as sea lions do. They are fond of basking in the sun, especially at low tide. On the land they are clumsy creatures. They move by pulling themselves forward by their foreflippers; in swimming the hind flippers do most of the work. The rookery here shown is at Cypress Point, near Pacific Grove, California, where the animals were obtained.

Group prepared under the direction of John Rowley.

The background was painted by Charles Bradford Hudson.

Photo by Gabriel Moulin.







## EXPLANATION, PLATE 11

## CALIFORNIA SEA LION

*(Zalophus californianus)*

This sea lion occurs on the sea coast and islands of California from San Francisco southward, breeding in many places, particularly on the Santa Barbara Islands. The rookery here shown is on Santa Cruz Island.

Owing to their intelligence and small size this is the species of sea lion that is commonly trained and shown in zoological gardens and elsewhere. The males are darker in color than the females, and are sometimes called black sea lions. Another characteristic of the male of this species is the great development of the bony crest on the top of the skull.

In early days sea lions were killed by thousands on the California coast for their hides and oil, but they have now become so reduced in numbers that sealing is no longer profitable. Sea lions as well as leopard seals are now protected on the California coast both by the State and Federal Governments. Among sealers the males are called "bulls," the females "cows," and the young "pups." The breeding season is from June to August, only during which time the males are found on the rookeries; at other times they go off in bands or singly living their lonely life.

Group prepared under the direction of John Rowley.

Background painted by Worth Ryder.

Photo by Gabriel Moulin.







## EXPLANATION, PLATE 12

## STELLER'S SEA LION

*(Eumetopias stelleri)*

This magnificent animal ranges from the Santa Barbara Islands northward into Bering Sea. Formerly very abundant, persistent killing for its hides and oil has reduced its numbers greatly. Within the last few years they have entirely ceased breeding on the famous Seal Rocks near the Cliff House at the Golden Gate. A few individuals still resort to these rocks, but they no longer breed there.

These animals reach a large size. The adult bull shown in the group weighed 1,810 pounds. There is a great difference in size between the sexes, the females being not more than half as large as the males.

Fishermen almost without exception claim that the sea lions are very destructive to the commercial fisheries. This is probably true at certain seasons and in some localities, but investigations have not fully sustained the charge.

The breeding season of this species on the California coast is the latter half of June. One young is produced at a birth.

The noise made by the Steller Sea Lion is a loud roar, resembling that of a real lion; this, together with the long yellowish hair of the necks of the bulls, doubtless suggested the name sea lion.

This group shows the breeding rookeries on Año Nuevo Island just south of San Francisco.

Group prepared under the immediate direction of John Rowley.

Background painted by Charles Abel Corwin.

Photo by Gabriel Moulin.







## EXPLANATION, PLATE 13

## CALIFORNIA RACCOON AND STRIPED SKUNK

*(Procyon psora and Mephitis occidentalis)*

This Raccoon is found throughout most parts of California, it being especially abundant in the heavily timbered country along the coast.

The Coon breeds in hollow trees, in holes in the rocks, in blind ditches, and even on the ground in tule swamps.

Coons are omnivorous; they eat shellfish, frogs, fish, and corn; they sometimes enter hen houses and kill and devour chickens.

In the South the negroes are very fond of the Raccoon, regarding its flesh as a delicacy. The Raccoon ranks third in value among the fur bearers of California.

The species of skunk shown in this group occurs throughout northern California except in the warmer interior valleys from Monterey northward.

The skunk brings forth its young in holes in the ground, beneath buildings, in stone piles or in hollow logs. They feed largely on insects, but will eat flesh of any kind, including chickens.

As a fur bearer the skunk is among the most valuable in the United States. In some States skunk farming has become a profitable industry.

Group prepared under the direction of John Rowley.

Photo by Gabriel Moulin.







## EXPLANATION, PLATE 14

## COYOTE

*(Canis ochropus)*

The Coyote, in its various forms, ranges throughout the United States west of the Mississippi and from Mexico to Canada. In California four species or subspecies are recognized. The one shown here occurs west of the high Sierras and south to the Mexican line. It is still only too abundant in many places. The family shown in this group was obtained in Moraga Valley near Mount Diablo, which is shown in the background.

The Coyote is very destructive to sheep, young pigs and poultry. Because of its great sagacity and nocturnal predatory habits, it has always been a great nuisance to the stock and poultry raiser. Because of this and its destructiveness to the smaller wild animals, especially birds, a bounty is paid for its capture in many counties of California.

In the colder parts of its range the Coyote develops a good coat of fur and the pelts have a fair commercial value.

Group prepared under the direction of John Rowley.

Background painted by Maurice G. Logan.

Photo by Gabriel Moulin.







## EXPLANATION, PLATE 15

## FARALLON ISLANDS BIRD ROOKERY

In this group, presented to the California Academy of Sciences by Hon. Wm. H. Crocker, are shown the ten species of sea birds and the one land bird (the little rock wren) that breed on the Farallon Islands. These rocky islands are about thirty miles off the Golden Gate, from which they may be seen on any clear day. Thousands of sea birds resort to these cliffs to lay their eggs and rear their young, one of the most common species being the Western Gull, which, during the rest of the year, is very abundant about San Francisco, following the ferry boats across the bay.

Until a few years ago thousands of Murre's eggs were brought each year from these rookeries and sold in San Francisco to the bakeries and pastry shops. The islands are now a Federal reservation and the birds and their eggs are rigidly protected.

The species of birds shown in this group are the following: Tufted Puffin, Brandt's Cormorant, Baird's Cormorant, Farallon Cormorant, Pigeon Guillemot, Western Gull, California Murre, Ashy Petrel, Kæding's Petrel, Cassin's Auklet, and Rock Wren, the last being the only land bird that breeds on these islands.

Group prepared under the direction of Paul J. Fair.

Background painted by Maurice G. Logan.

Photo by Gabriel Moulin.







## EXPLANATION, PLATE 16

## SAN JOAQUIN VALLEY BIRD GROUP

In the spring and early summer it is the practice of the cattlemen of the San Joaquin Valley to flood their land with water, to a depth of six to eighteen inches, to induce a ranker growth of grass for pasture. Many thousand acres are thus flooded and converted into marsh land, to which vast numbers of ducks, waders and other swamp-loving birds are attracted. During the breeding season great numbers of birds resort there to build their nests, lay their eggs, and rear their young. These breeding grounds are frequented by more than thirty species of birds. Among those shown in this group, which shows a typical breeding ground near Los Baños, Merced County, California, are the Fulvous Tree Duck, Cinnamon Teal, Shoveler, Redhead Duck, Coot, American Bittern, Least Bittern, Glossy Ibis, Avocet, Black-necked Stilt, Killdeer, Red-winged Blackbird, Yellow-headed Blackbird, Tule Wren, Little Black Tern, Forster's Tern, and the Virginia Rail. In order to show in a limited area a considerable number of species it was necessary to bunch the birds a little more closely than they actually occur in nature.

Presented to the Museum of the California Academy of Sciences by Hon. Joseph D. Grant.

This group was prepared under the immediate direction of Paul J. Fair.

The background was painted by Maurice G. Logan.

Photo by Gabriel Moulin.







## EXPLANATION, PLATE 17

## DESERT BIRD GROUP

In this group, presented to the California Academy of Sciences by Hon. Wm. B. Bourn, are shown, under natural surroundings, several species of the birds that nest in the Colorado and Mohave deserts of southern California. The particular locality represented is near Cottonwood Springs, 26 miles northeast of Mecca, Riverside County, California.

The spring rains transform the desert into a veritable flower garden, and many and varied forms of vegetation send forth an astonishing amount of beautiful bloom. Then is the nesting time of the birds, which are there in surprising numbers, some of them, as the Hooded Oriole and the Vermilion Flycatcher, rivaling the flowers in brilliancy of coloration.

The total number of species of birds nesting in this part of the Colorado desert is more than a score, and some species, as Gambel's Quail, are very abundant. The nests, however, are usually widely scattered except in the vicinity of water.

The following species of birds are shown in this group: Phainopepla, Costa's Hummingbird, Mourning Dove, White-rumped Shrike, Plumbeous Gnatcatcher, Lincoln Sparrow, Western Mockingbird, Texas Woodpecker, Desert Sparrowhawk, Vermilion Flycatcher, Bullock's Oriole, Arizona Hooded Oriole, Roadrunner, Cactus Wren, House Finch, Texas Night-hawk, Gambel's Quail, Desert Sparrow, Leconte's Thrasher, Arkansas Kingbird, Verdin and Abert's Towhee. The principal plants shown are: The Palo Verde, Spanish Bayonet, Deerhorn Cactus, Prickly Pear Cactus, Barrel Cactus, Ocotilla, and the Smoke Tree or Palo Blanco.

Group prepared under the immediate direction of Paul J. Fair.

Background painted by Charles Bradford Hudson.

Photo by Gabriel Moulin.





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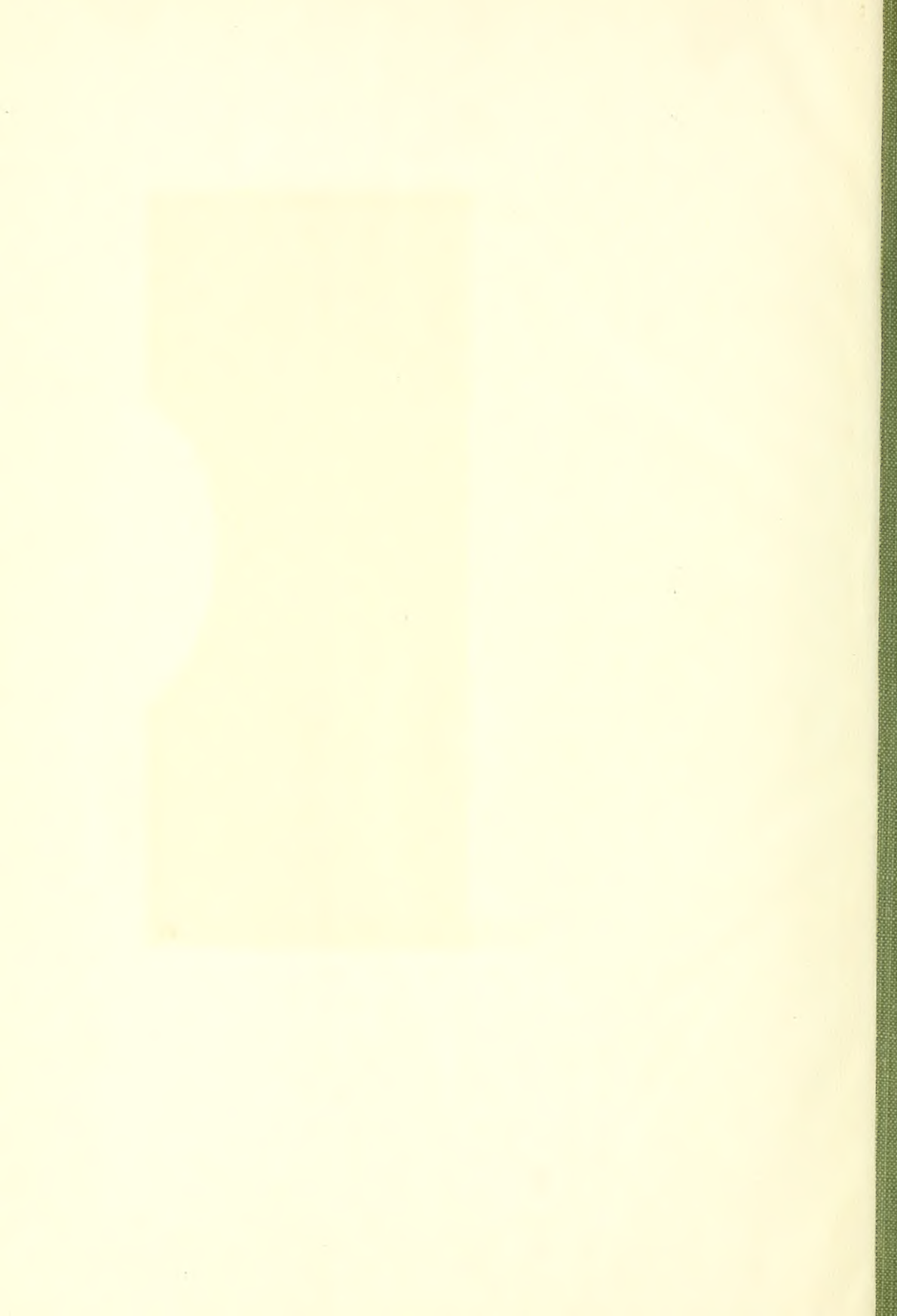
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